Chapter 3: Refuge Environment and Management

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3.1 Geographic/Ecosystem Setting

Hamden Slough National Wildlife Refuge (NWR, Refuge) is located on the eastern edge of the Prairie Pothole Region (PPR), within the Northern Tallgrass Prairie (NTGP) ecosystem of northwest Minnesota (figure 3-1). The Refuge is in west-central Becker County, just northeast of the town of Audubon, MN. The landscape of west-central Becker County is dominated by row crop agriculture. Immediately east of the Refuge is the Prairie-Forest transition zone, which gives way to the Eastern Broadleaf Forest and Northern Coniferous Forest (figure 3-2). The 3,210-acre Refuge contains a diverse landscape of mesic and wet mesic tallgrass prairie, small prairie potholes, and larger wetlands and shallow lakes (Heitmeyer et al., 2012).

Figure 3-1: Prairie Pothole Region

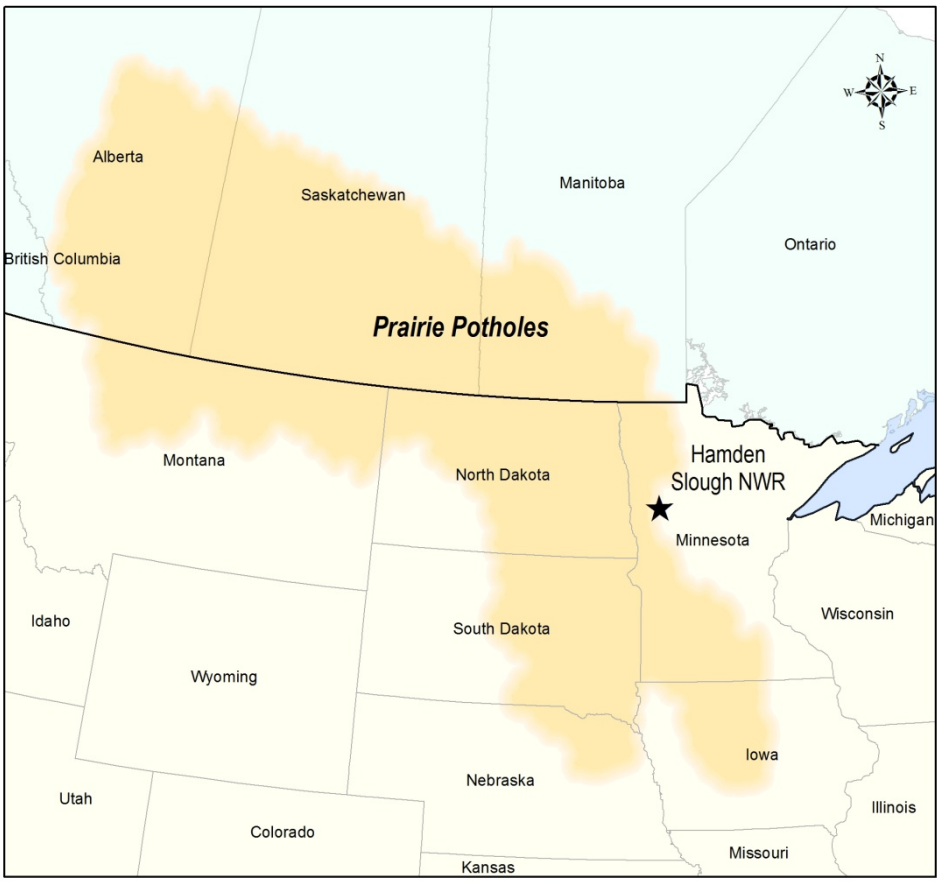
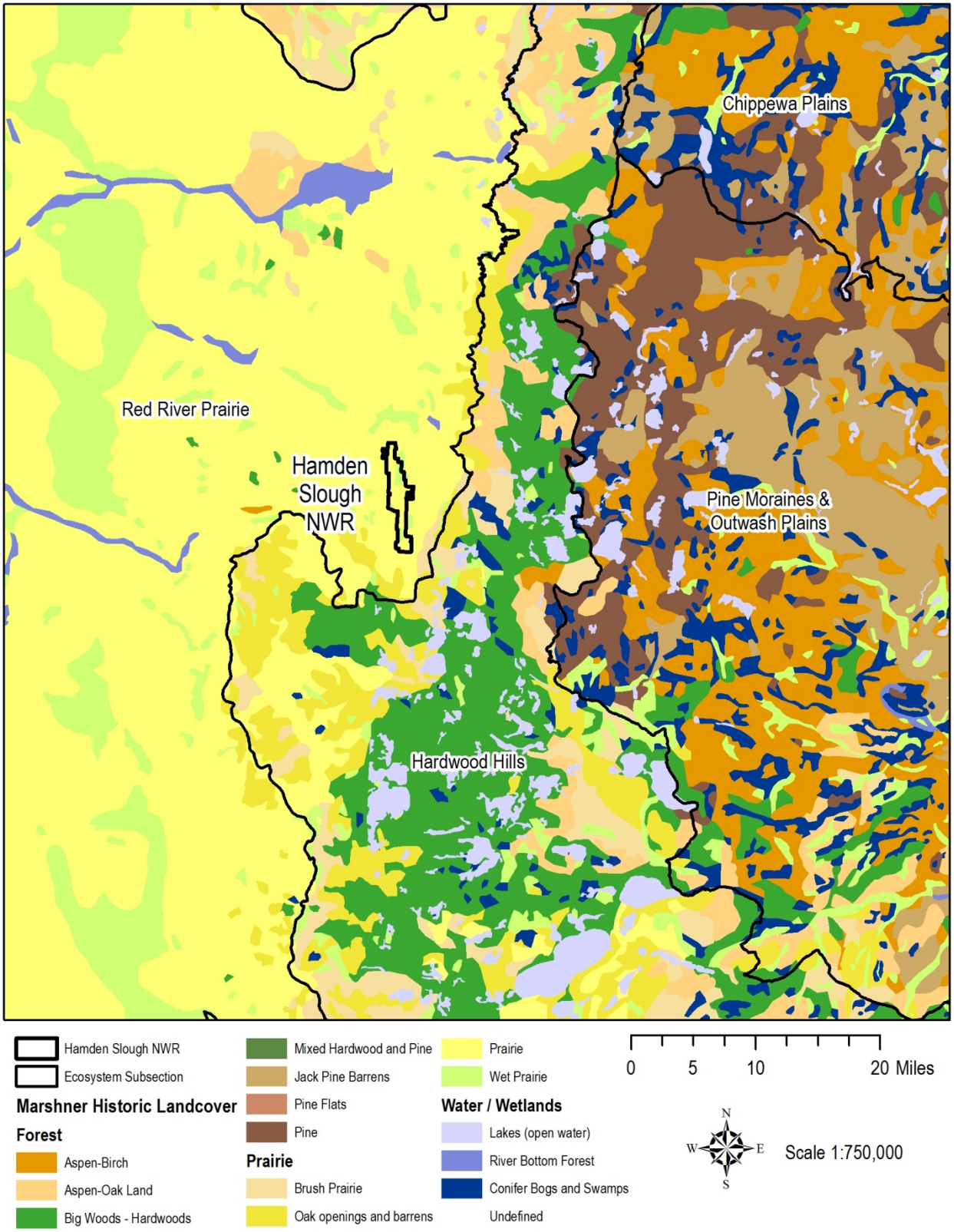


Figure 3-2: Prairie Forest Transition



Prairie-Wetland Complexes

The NTGP of Minnesota once covered 18 million acres (Sampson and Knopf, 1994). Numerous pothole wetlands dotted the landscape and were surrounded by prairie grasses and wildflowers. The original density of wetlands in the region averaged 83 per square mile. These prairie-wetland complexes provided habitat for a multitude of wildlife, especially birds. This is evident by the numerous historical accounts that remark on the abundance of birds using wetlands and prairies of the Hamden Slough area. For example, one account reads, “Hamden was worse than Cuba [Township] for sloughs and ponds; they were all alive with ducks and geese, and sand-hill cranes were seen stalking about over the prairies or flying overhead every day, and sharp-tailed grouse or native prairie hens were abundant, especially in the vicinity of the few small groves and patches of hazelbrush.” (Wilcox,1907).

This vast system of prairies and wetlands, a relic of the Wisconsin glacier, is only a memory along with many of the wildlife species that inhabited the region. Roughly 85 percent of Minnesota’s wetlands have been drained (Johnson et al., 2008), and only 170,000 acres of remnant tallgrass prairie remain in Minnesota (Minnesota County Biological Survey, 2008); a decline of roughly 99 percent.

Density of Wetlands

The Mississippi Flyway

Hamden Slough NWR is situated at the confluence of the Mississippi and Central flyways, a transition area between prairie wetlands and hardwood forest ecoregions (figure 3-3). The Mississippi flyway contains the longest migration route of any North American flyway, more than 3,000 miles (Lincoln et al., 1998). There are no mountain ranges or ridges to impede bird migration through this thoroughfare. In fact, the north to south orientation of the Mississippi River, one of two major river systems in the flyway, makes travel conditions even better for the large numbers of ducks, geese, shorebirds, and songbirds (Lincoln et al., 1998) that use this flyway.

Figure 3-3: Migratory Flyways

Historically, the area now known as Hamden Slough NWR also was important for migratory birds. Its location within the long, north-south corridor between glacial Lake Agassiz to the west and outwash slopes extending from the Great Lakes to the east made the region a natural “funnel” for migratory birds (Heitmeyer et al., 2012). The importance of the area is still evident today. Birds using the waters of Hamden Slough NWR include more than 20 shorebird species, all major waterfowl species, rail species, and Forster’s terns (Robert Russell, personal communication) among others. Under optimal conditions, Refuge wetlands can hold more than 10,000 waterfowl and other waterbirds during spring and fall migrations

Other Conservation Lands

Despite the large amount of cropland in the area, additional conservation lands in the vicinity of the Refuge do exist. Most are managed for prairie and wetland habitat that supports the foundation of Hamden Slough NWR (figure 3-4). The Detroit Lakes Wetland Management District (WMD, District) manages more than 45,000 acres of Waterfowl Production Areas (WPAs) in five counties of northwest Minnesota, including Becker County. Due to the base acres that Hamden Slough provides, the District has declared the area surrounding the Refuge a high priority for land acquisition. Within two miles of the Refuge boundary, ten WPAs containing approximately 2,865 acres of prairie-wetland habitat are managed for waterfowl and other migratory birds. In essence, Hamden Slough NWR acts as an anchor for these smaller Waterfowl Production Area (WPA) tracts. Together, the Refuge and nearby WPAs are managed as a corridor, providing habitat for waterfowl and other wetland-dependent birds as well as prairie-obligate species. Numerous other WPAs are located near the Refuge but do not fall within the two-mile boundary.

Wildlife Management Areas (WMAs) managed by the Minnesota Department of Natural Resources (DNR) also may contribute to the purposes of the Refuge. These are public lands managed primarily for resident wildlife, but migratory birds also benefit. Although there is only one WMA near the Hamden Slough watershed boundary, there are additional WMAs north and west of the Refuge that complement the nearby WPAs.

Private lands near the Refuge also can play an important role in conservation. Originally, the Refuge was buffered by an easement zone allowing an additional 2,600 acres of land to be protected via a combination of easements, leases, and conservation farming agreements. Today, under management of the Detroit Lakes WMD, the Service already has authority under the Small Wetlands Program for easements, leases, and agreements throughout Becker County, including adjacent to the Refuge. The Service has purchased wetland easements from some landowners within the watershed to benefit waterfowl and other wetland-dependent wildlife.

The Service's Partners for Fish and Wildlife Program (PFW, Partners Program) shares the cost and provides technical assistance to restore and manage wetland and prairie habitat on private land. A few PFW projects have occurred within the Hamden Slough watershed but most, if not all, are expired due to a minimum ten-year agreement requirement. Some landowners have enrolled land into U.S. Department of Agriculture (USDA) programs such as the Conservation Reserve Program and Wetland Reserve Program. These lands support the purposes of the Refuge by providing upland and wetland habitat for migratory birds and other wildlife. Private lands used for cattle production generally provide suitable habitat for some grassland birds during certain times of the year and are more beneficial than row crops to most wildlife.

The northernmost portion of Hamden Slough NWR, approximately 600 acres in Sections 27 and 34 of Riceville Township, lies within the boundary of the White Earth Reservation. The reservation was established in 1867 by a treaty signed between the United States and the Mississippi Band of the Chippewa (Ojibwe) Indians. It encompasses all of Mahnomen and parts of Becker and Clearwater Counties, roughly 1,300 square miles. The White Earth Band of the Ojibwe is a sovereign nation. The Tribal government ensures broad powers (self-governing) and is immune from state interference. It is also afforded certain immunities similar to other federal entities. The lands of the White Earth Reservation include vast prairies and wetlands, as well as broadleaf and pine forests, and are managed to allow maximum usage by Tribal members while maintaining wildlife populations capable of regeneration.

Within two miles of the Refuge boundary, more than 60 percent of the land base (approximately 24,000 acres) is farmed annually (figure 3-5). This acreage includes land used for hay, and although it may provide some cover, it is equally detrimental in that those fields typically are cut multiple times per growing season. It is clear that there is a lack of permanent cover for grassland birds within two miles of Hamden Slough NWR.

Figure 3-4: Other Conservation Lands

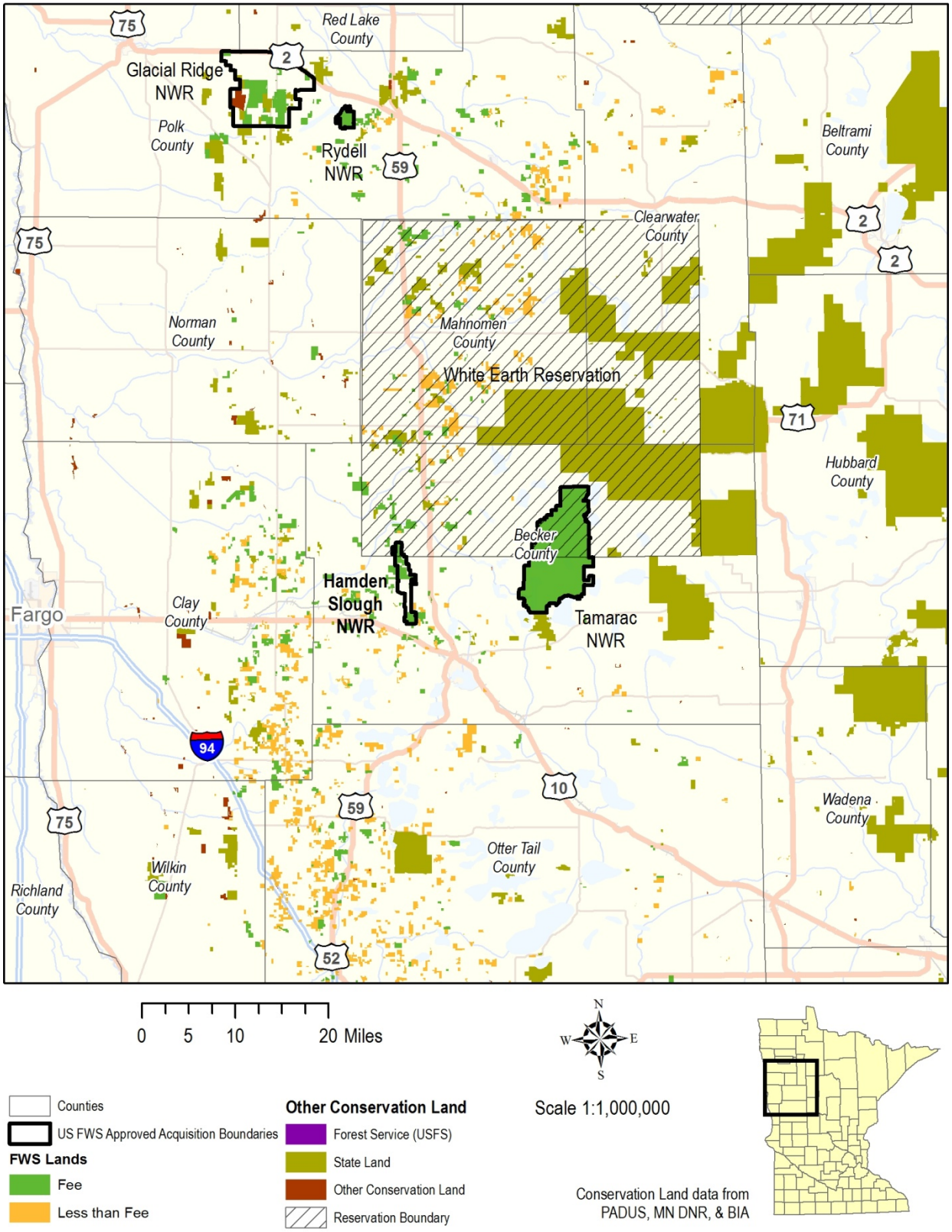
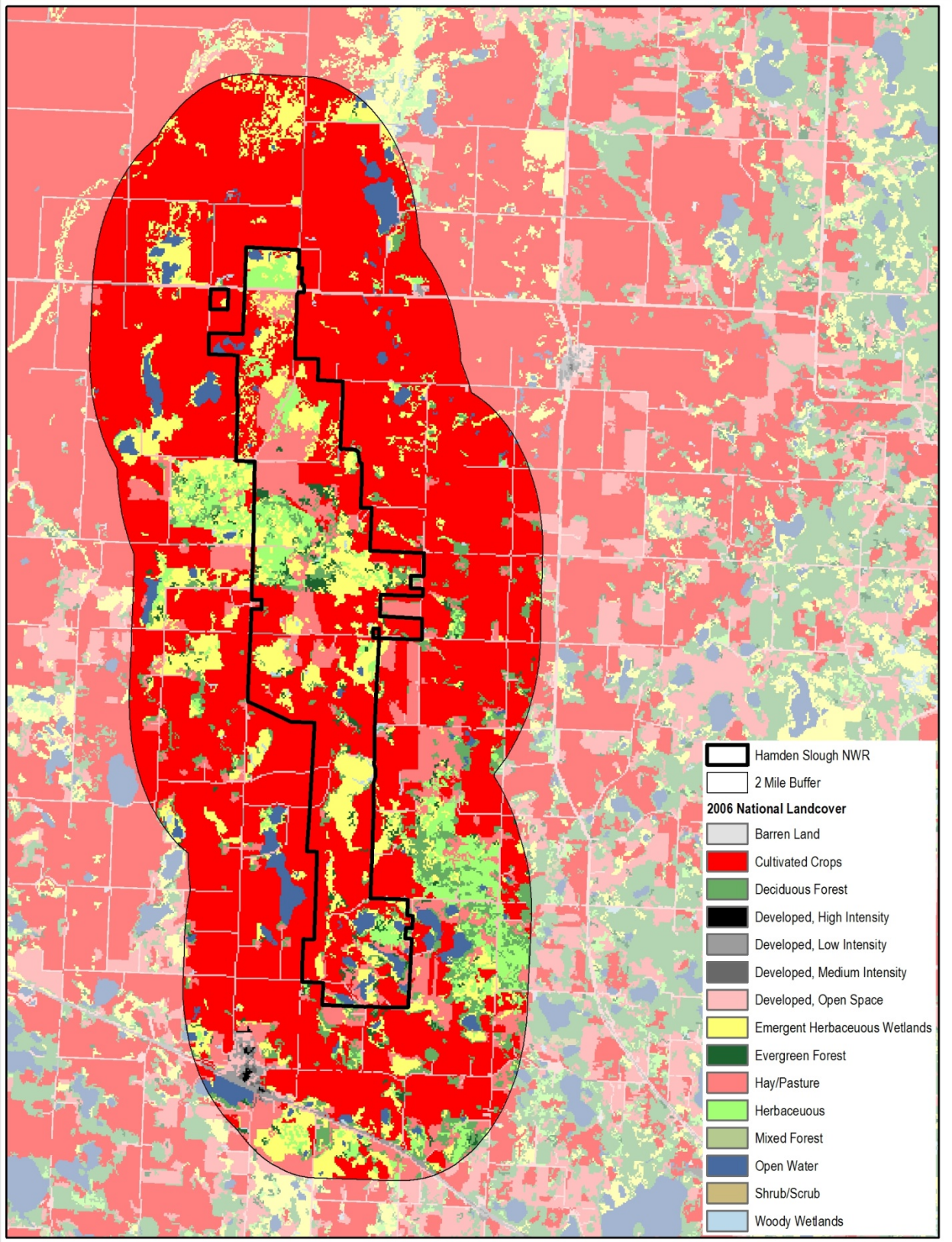


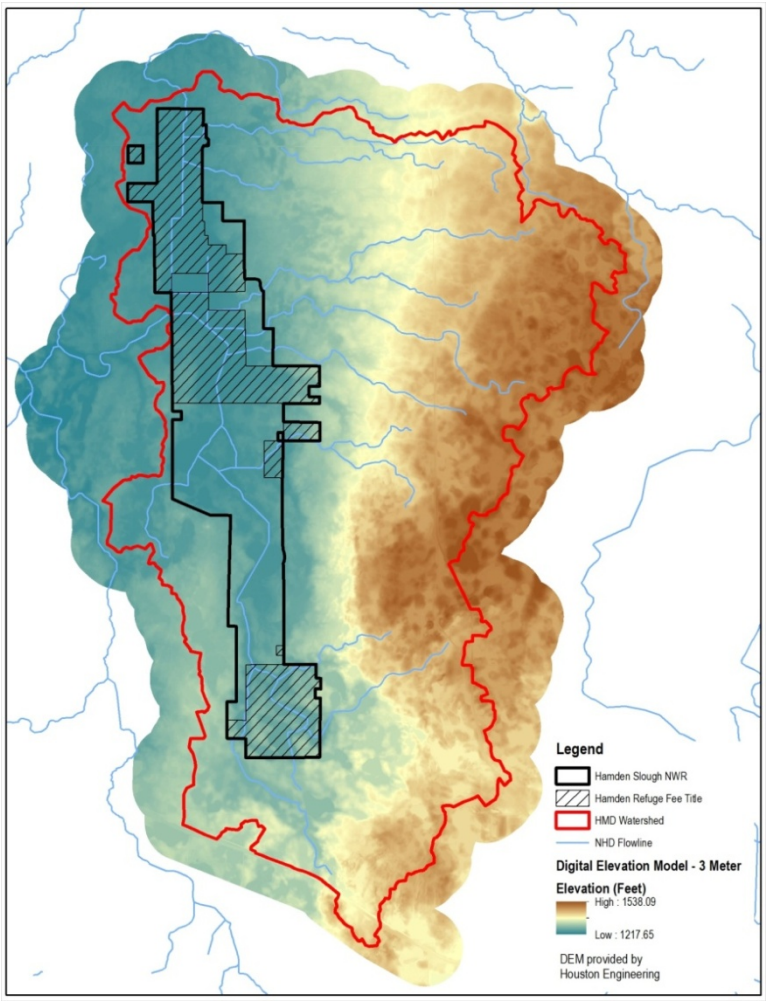
Figure 3-5: Two-Mile Buffer



3.2 Physical Environment

The landscape that encompasses Hamden Slough NWR is a direct result of the most recent glaciation, the Wisconsin, approximately 12,000 years ago. The recession of the glacier left a range of topographies from steep slopes to nearly level drainages. Uneven deposits of glacial till and loess (the foundation of the rich organic soils sought after for agricultural production), the scouring action of the glaciers, and the melting of large ice blocks created high densities of pothole wetlands (Euliss et al.,1999), the namesake of the PPR.

Figure 3-6: Elevation



Geology

The bottommost layer beneath Hamden Slough NWR is comprised of undifferentiated Precambrian crystalline rock. Cretaceous sedimentary rock overlies the Precambrian layer, followed by a top layer of unconsolidated glacial till 300 to 600 feet thick. This till layer is from the Wisconsin Glacier and is among the thickest in Minnesota (Christensen, 1998). Two lobes of the Wisconsin glacier helped form the surficial geomorphology of the Refuge. The Des Moines lobe, the more recent of the two, left most of the deposits in this portion of Becker County, including the northern and central parts of the Refuge. These areas are dominated by flat, wet ground moraine. The Wadena Lobe formed the Alexandria Moraine, a large glacial outwash slope that lies along the extreme eastern boundary of the Refuge. The south unit of the Refuge lies near the boundary of this advance. It is dominated by terminal moraine, which gives the area a distinct hill and lake appearance.

Topography

The topography of Hamden Slough NWR is heterogeneous due to the extensive glacial movements and scouring of moraine material (Heitmeyer et al., 2012). Recently completed digital elevation models for the Refuge indicate a range of elevations from 1,218 feet above mean sea level (amsl) to 1,500 feet amsl (figure 3-6, Heitmeyer et al., 2012). The northern portion of the Refuge, dominated by ground moraine and flatter northern till plain surfaces, contains the historic Hamden Lake. A higher density of larger pothole wetlands and shallow lakes are found in the southern portion of the Refuge due to the terminal moraine surfaces that exhibit greater changes in topography. The Refuge is the lowest elevation within the 48 square mile Hamden watershed, which provides excellent wetland conditions even in drier periods. The most prominent feature is the glacial outwash slope, the Alexandria Moraine, rising 200 feet on the east side of the Refuge.

Soils

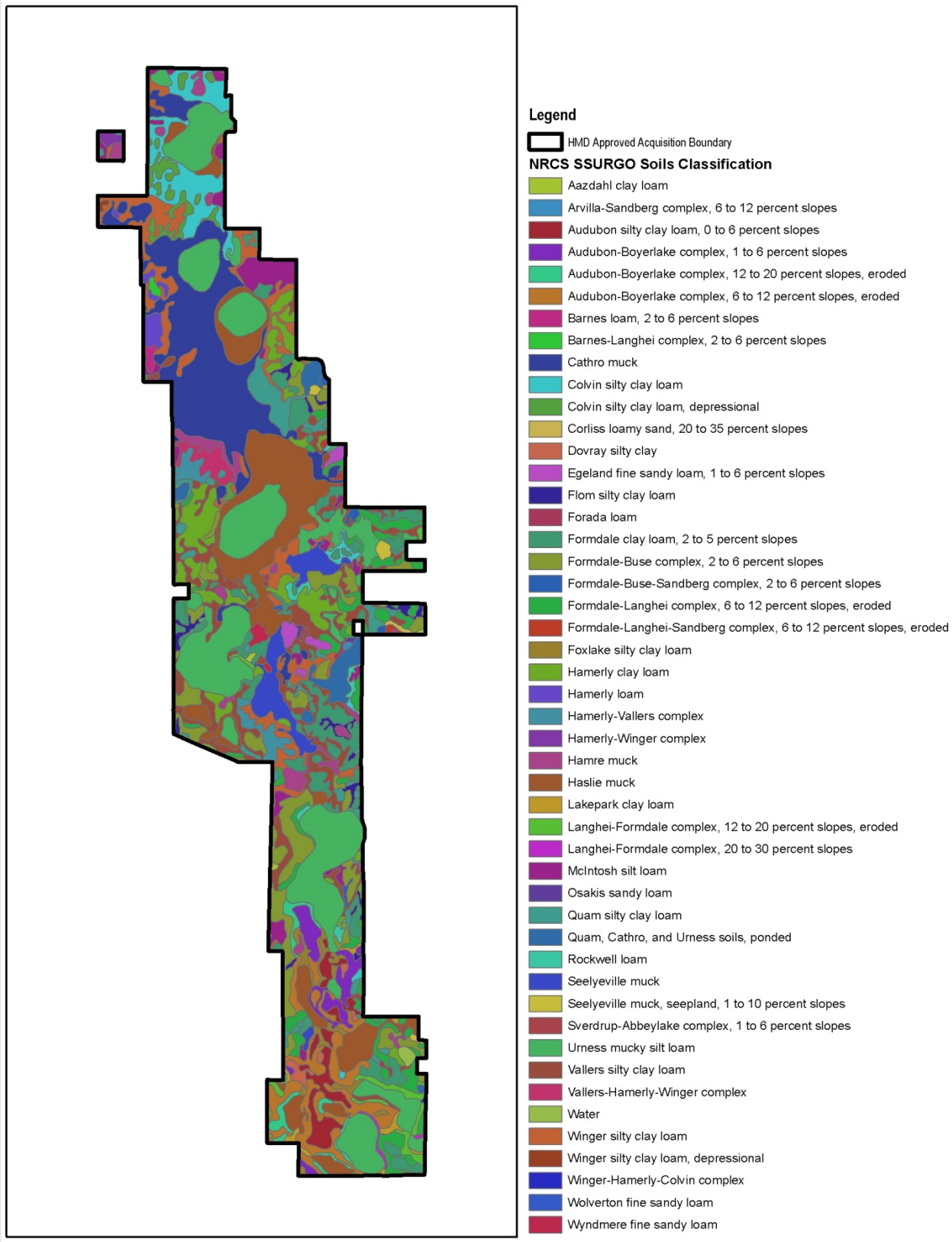
Over 30 major soil types can be found on Hamden Slough NWR (figure 3-7). Generally, the northern portion of the Refuge has nearly level, loamy and silty soils on ground moraines and contains the Hamerly-Winger-Vallers Association. These soils were formed in glacial till (Hamerly and Vallers) and in 20 to 40 inches of glacial lacustrine sediments overlying glacial till sediments (Winger). Slopes are nearly level, ranging from zero to three percent in most areas, and are poorly drained.

The central and southern portions of the Refuge contain nearly level to moderately steep, loamy, silty, and organic soils on lateral moraines and include the Formdale-Langhei-Flom Association (central portion) and the Birchlake-Audubon-Foxlake Association (southern portion). Both associations formed in glacial till sediments and slopes are nearly level to hilly (0 to 30 percent). These areas are moderately-to-well drained.

The prominent hydric feature of the Refuge, the relict Hamden Lake, is comprised of Cathro and Haslie muck soils. This is true for the other glacio-lacustrine depressions (Bisson, Pierce, and Homstad Lakes). Numerous depressional (or ponded) soils found in the pothole wetlands include Colvin, Dovray, Winger, Nidaros, Quam, Seeleyville, Urnerss and Vallers soils. Drainages between hills and slopes have Flom, Forada, Foxlake, and Lamoure silt clay loam soils.

Upland soils, forming slopes and hills of the Refuge, are mostly loam-dominant including Arvilla, Barnes, Formdale, Langhei, and Sverdrup-Abbeylake types and minor components of Bootlake, Eagleview, and Corliss sandy loams. One unique “seep” type soil, Seelyville, is present along a moraine side hill (Heitmeyer et al., 2012). Other seeps may be present on the Refuge, although none have been documented.

Figure 3-7: Soils



Hydrology

Hamden Slough NWR is located within the greater Red River Basin of the Buffalo River watershed. Water flows primarily northward through the Refuge and then west into the Buffalo River. The Buffalo River empties into the Red River, which flows north into Hudson Bay, Canada. The smaller Hamden Slough watershed is approximately 48.7mi^2 (31,200 acres) and 4.5 percent of the Buffalo River watershed (figure 3-8) (Newman and Eash, 2011). The Refuge lies over a fairly shallow aquifer and, thus, has an accessible water table supplying the area with relatively high yields of water at times. There is considerable surface-groundwater interaction (discharge-recharge), a key component of the water supply and function of Refuge wetlands. Groundwater movement tends to be of east-west flow, given the topography and soils (figure 3-9). Therefore, it is likely that additional seeps and fens exist along the base of the steeper slopes on the eastern edge of the Refuge (Newman and Eash, 2011).

Figure 3-8: Buffalo River Watershed

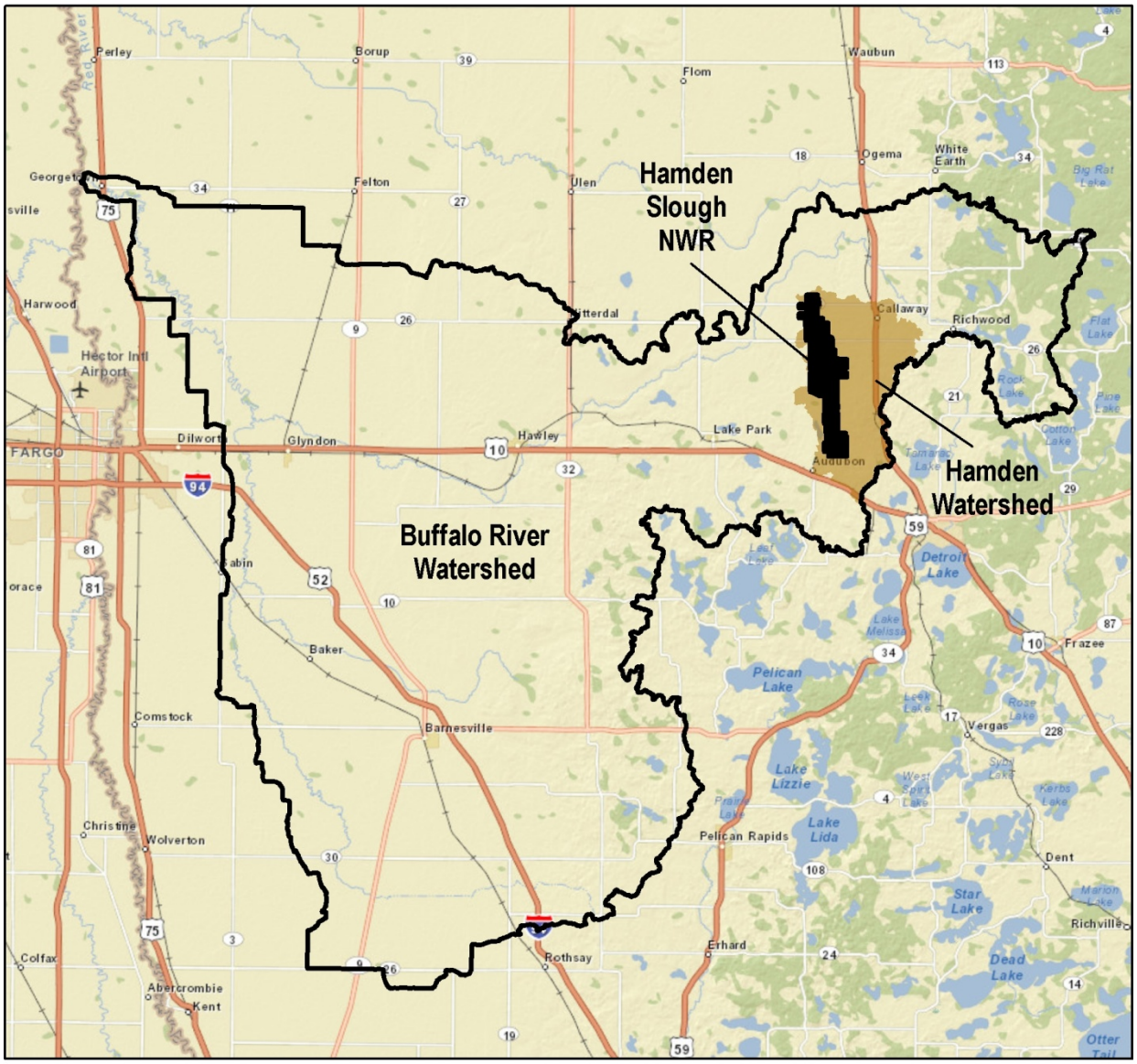
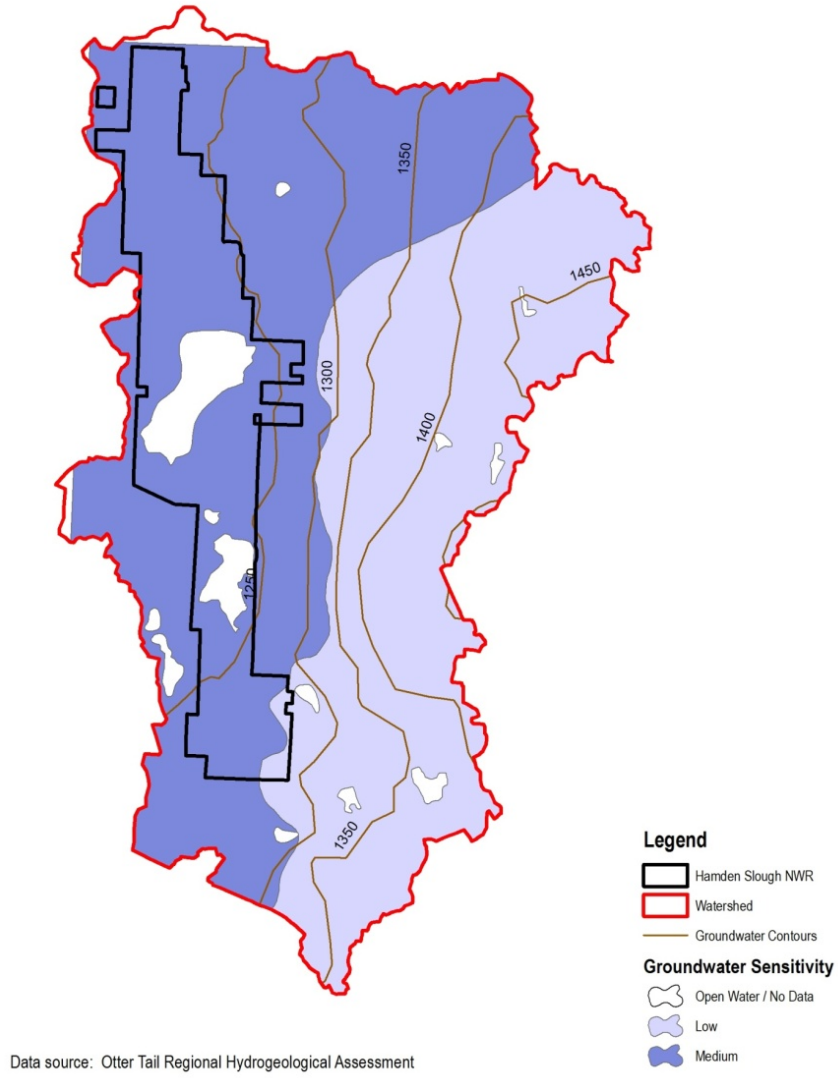


Figure 3-9: Groundwater



Historically, several small local streams drained from the east and south into and through the Hamden Slough area (figure 3-10). Water draining into the area was captured and held in several larger wetland basins that apparently were interconnected during high flow, wet years, and subsequently drained from the area into the Buffalo River. Local surface and groundwater runoff drained into several hundred small isolated wetland depressions or potholes on the Refuge (figure 3-11), but because of the topography, there was limited output into the larger system, except during wet years (Heitmeyer et al., 2012).

Figure 3-10: Watershed Drainage

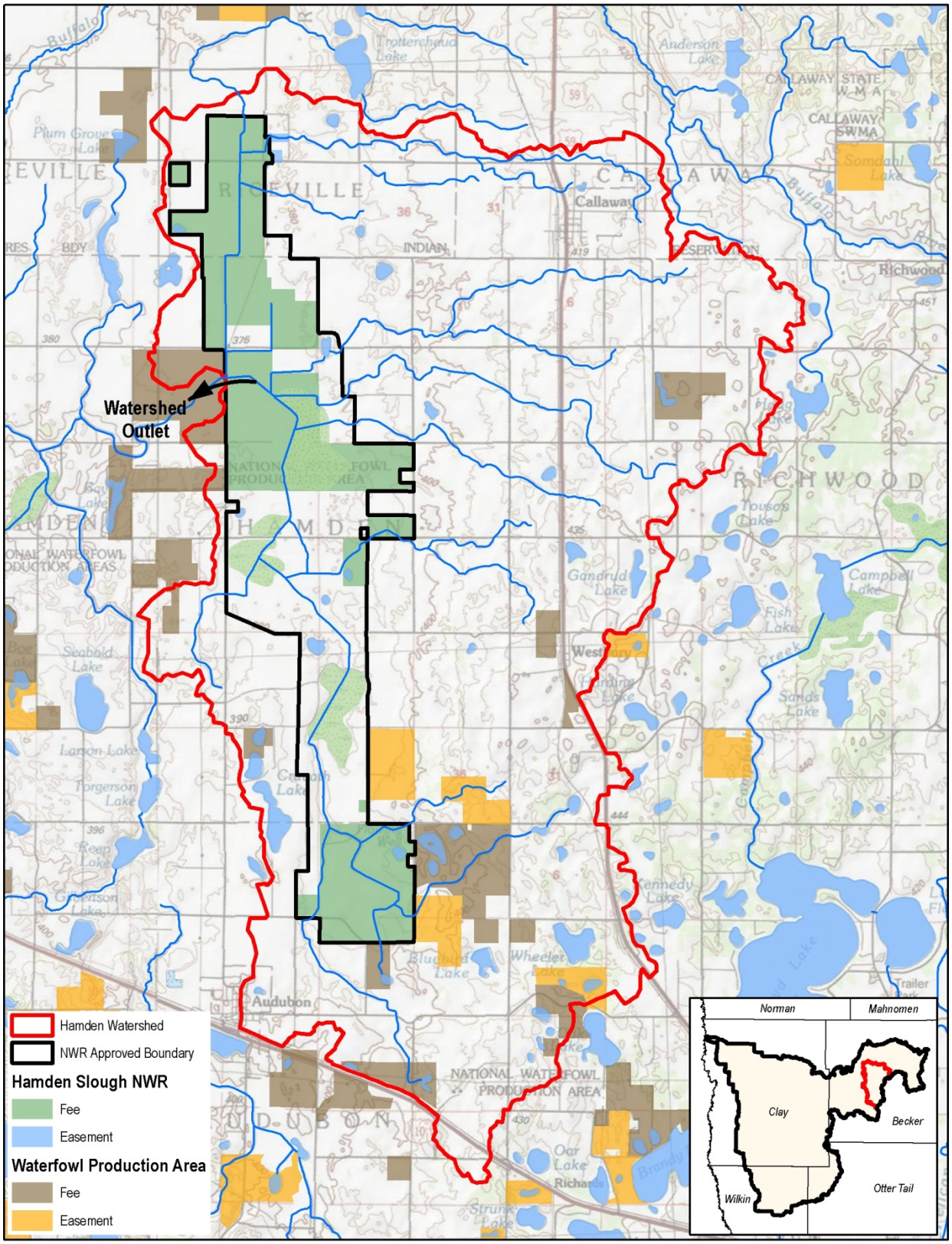
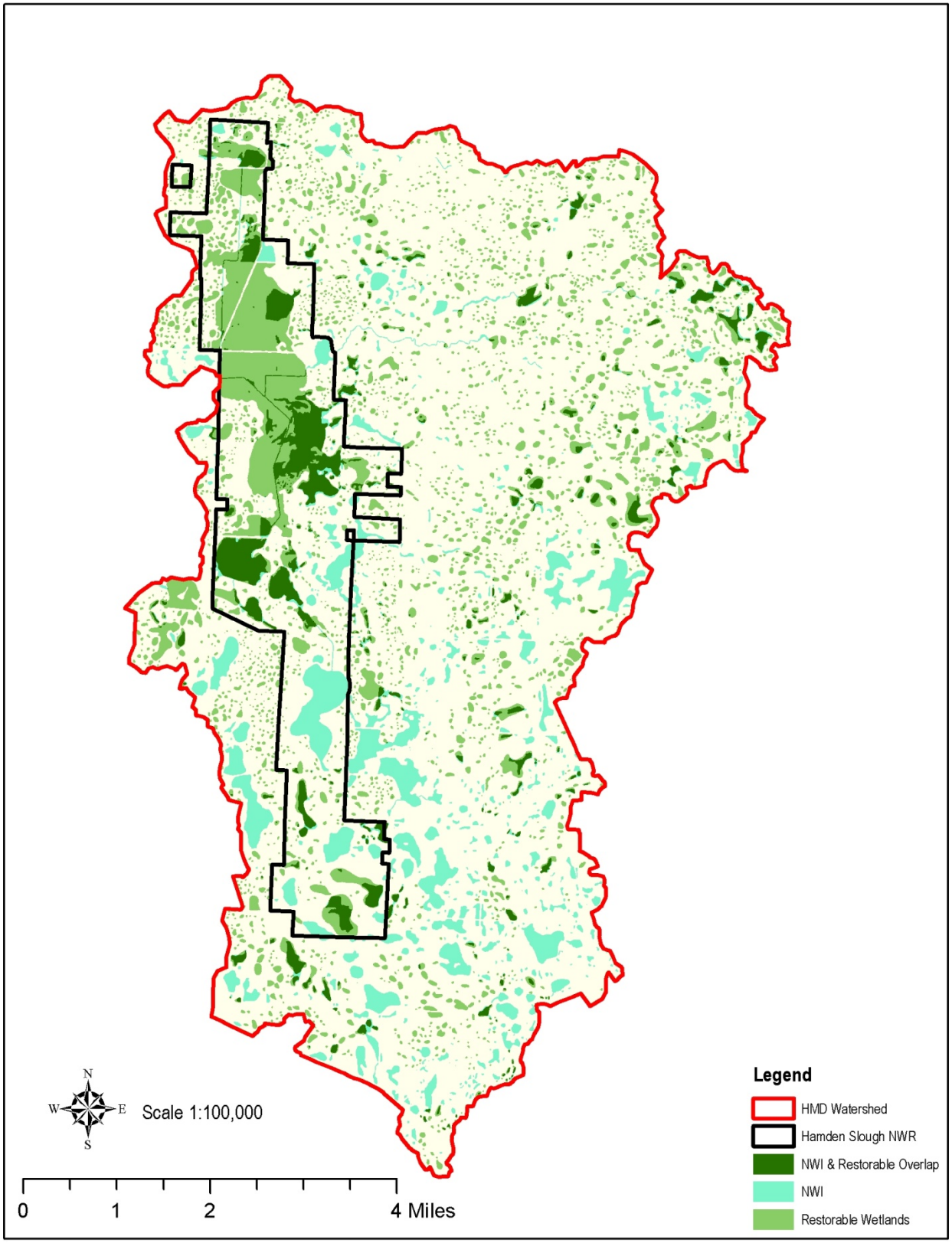


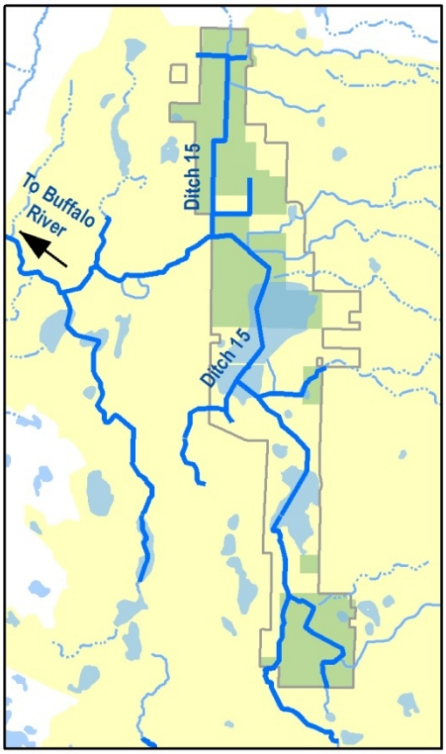
Figure 3-11: Distribution of Wetlands



Ditch 15 System

The greater Red River Basin, including the Hamden Slough watershed, has been heavily altered by drainage ditches and tiles for the production of commodity crops such as sugar beets, corn, and soybeans. Extensive drainage of the Hamden Slough area began in the early 1900s with the construction of the Ditch 15 system, initially for mosquito control. This system drained the small, shallow temporary and seasonal wetlands effectively; however, some of the larger, dynamic wetlands and lakes were more difficult to fully drain. Today, this linear, interconnected system is the main transport of surface water through the Hamden watershed, including the Refuge, for agricultural purposes (figure 3-12). The Ditch 15 system is managed by the Buffalo-Red River Watershed District (BRRWD). On Refuge property, maintenance of the main ditch and its laterals is jointly conducted under a cooperative agreement between the BRRWD and the Service. The cooperative agreement designates the Service as responsible for some ditch cleaning and maintenance to ensure the pre-established grade and depth are maintained unless changes are mutually agreed upon. Periodic excavations of the ditch involve disturbing sediments, which causes increased turbidity and sedimentation downstream (Heitmeyer et al., 2012). The ditch system also is highly susceptible to flash flooding during high precipitation events (Newman and Eash, 2011), which further impacts downstream lands within the greater Red River Basin.

Figure 3-12: Ditch 15 System

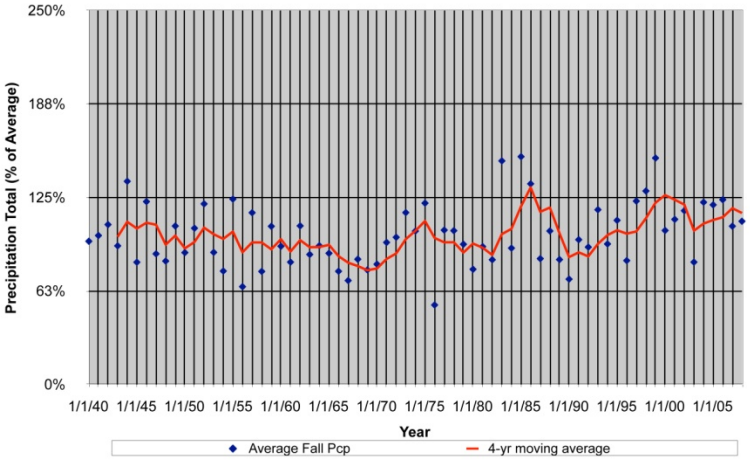


Current land use practices (pesticide and fertilizer applications, pasturing) and the alteration of hydrology (ditching and tiling) within the Hamden Slough watershed are primary sources of contaminants that could potentially impact the Refuge (Brozowski, 2010). Water chemistry and quality in the isolated depressional wetlands can be attributed to land use and runoff characteristics within the wetland basin, as well as the groundwater quality constituents discharged into the wetland. The ditch systems are potential primary source water for many of the larger flow-through wetlands and therefore, transport water-borne contaminants such as sediments, nutrients, animal waste (*E. coli*), pesticides, and fertilizers onto the Refuge (Brozowski, 2010). Based on current data from Minnesota Pollution Control Agency, the waters within the Hamden NWR boundary are not listed as “impaired,” although the lower reaches of the Buffalo River downstream of the Refuge do have “impaired status” for turbidity and *E. coli*. The evaluation for the full extent of the Buffalo River watershed is still under development.

Climate

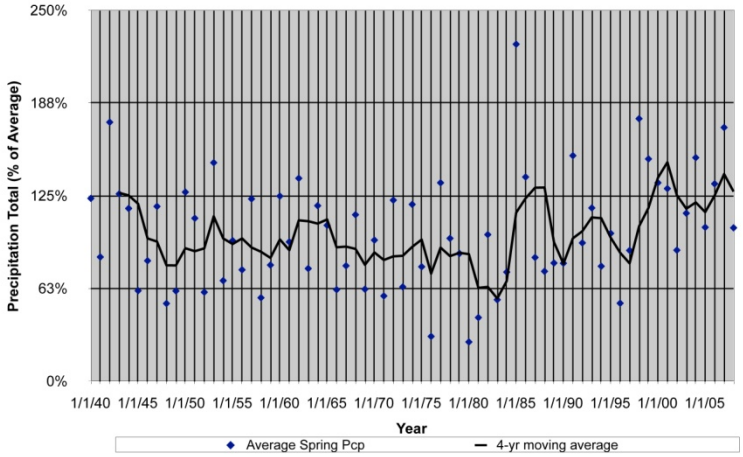
The climate of Hamden Slough NWR can be described as dynamic, attaining temperature and precipitation extremes at various times of the year and between years. Two topographically-influenced weather patterns dictate the climate of the Hamden Slough area at any given time. First, there is a steep precipitation gradient as weather moves east and lifts over the Red River Valley. For every ten miles of eastern movement, rainfall increases by one inch. In the 50 miles between the Red River and Hamden Slough NWR, annual precipitation increases from 19 to 24 inches, and the climate changes from semi-arid to subhumid. Second, Lake Superior's deep, cold waters during spring, summer, and fall influence the Refuge's weather when the airflow from the west is weak. This influence usually results in cooler than normal temperatures.

Figure 3-13: Annual Precipitation, 1940-2009, Detroit Lakes, MN



In general, summers are warm and moderately humid while winters are cold and dry. The warmest months of the year are July and August, with average temperatures in the 70s (degrees Fahrenheit), although temperatures often may be as high as 90 to 100 °F. January and February are typically the coldest months of the year, with average temperatures in the single digits to around 10 °F. However, it is not uncommon to experience temperatures in -20s °F and even lower wind chills. Average precipitation is 25 inches per year, most of it falling from April through September. Heaviest rainfall occurs during June, July, and August. Average annual snowfall is more than 60 inches. Snowfall events in winter can range from light snow with little or no accumulation to heavy snow events of eight inches or more.

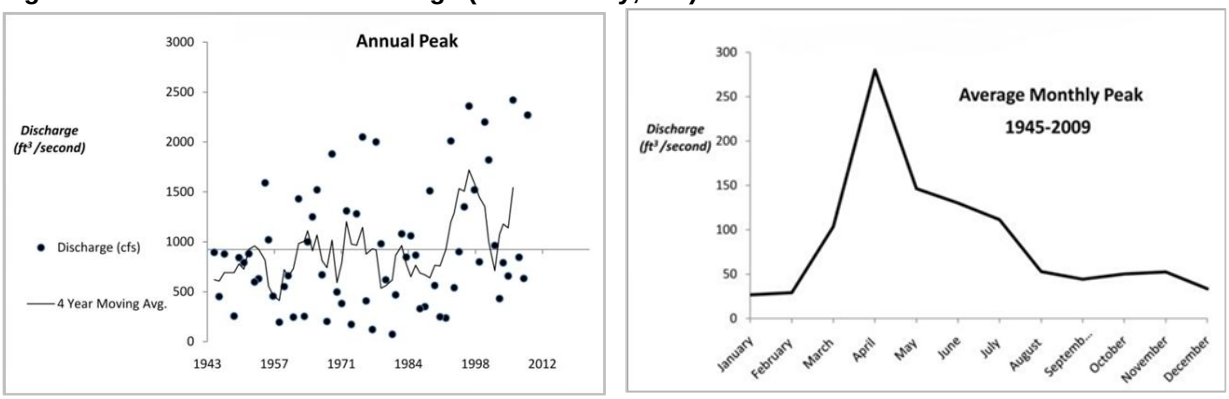
Figure 3-14: Spring Precipitation (Mar-May), Detroit Lakes, MN



Since 1940, dry years with more or less than 60 percent average annual precipitation occurred seven different times, about 10 to 14 years apart (i.e., 1955–59, 1967–68, 1977, 1991) (figure 3-13, Annual Precipitation; Heitmeyer et al., 2012). In contrast, wet years with greater than 120 percent average annual precipitation occurred in the mid-1940s, early-1950s, mid-1970s, mid-1980s, late-1990s, and mid-2000s (Heitmeyer et al., 2012). Analyses of spring only (March through May) precipitation also suggest regularly alternating wet versus dry conditions in the region (figure 3-14) with highly dynamic seasonal inputs of water to Refuge wetlands and streams, including the Buffalo River. The four-year running average annual peak discharge in the Buffalo River near Hawley, MN (where water from the Hamden Slough region drains) indicates alternating high (greater than 1,000 cfs) and low (less than 500 cfs) discharge at about 10 to 12 year intervals (figure 3-15, Buffalo River Discharge; Heitmeyer et al.,

2012). Depending on amount and moisture content of winter snowfall, and precipitation amounts and snowmelt duration in spring, large runoff events can occur in the Hamden Slough watershed and may add to flooding problems downstream in the Red River Valley.

Figure 3-15: Buffalo River Discharge (near Hawley, MN)



Climate Change and the PPR

Climate, as defined in *Climate Literacy: The Essential Principles of Climate Science* by the U.S. Global Change Research Program (USGCRP, 2009), is "the long term average of conditions in the atmosphere, ocean, and ice sheets and sea ice described by statistics, such as means and extremes." Climate change is a "significant and persistent change to the mean state of the climate or its variability" (USGCRP, 2009) and is likely caused by both natural and anthropogenic effects. The subject of climate change has been discussed, argued, and tested time and time again on whether or not it exists or has been exacerbated by human activities. However, the Intergovernmental Panel on Climate Change (IPCC) stated, in its Fourth Assessment (2007) that it had "very high confidence that the global average net effect of human activities since 1750 has been one of warming." This warming is mainly attributed to the trapping of three gases in the atmosphere: carbon dioxide, methane, and nitrous oxide.

Since the beginning of the 20th century, average surface temperature has risen 2.4 °F. Between 1996 and 2005, the earth experienced 11 of the warmest years on record since 1850 (IPCC, 2007), and 2009 and 2010 were reported as record-breaking years by NASA. Scientists predict that global climate change will accelerate in the 21st century. Potential consequences of increasing global temperatures include rising sea level and increasing frequency and intensity of heat waves, droughts, and floods (IPCC, 2007). In addition to the numerous direct and indirect impacts to humans, the world's wildlife also will be affected. The IPCC (2007) predicts that 30 percent of assessed species will have a greater risk of extinction with only a 3.6 to 5.4 °F increase in temperature.

Although wetlands are dynamic systems that fluctuate with changing weather, they also are very susceptible to climate change because of their shallow depths and high evapotranspiration rates (Johnson et al., 2010). Even slight temperature or precipitation changes could cause degradation or loss (North American Bird Conservation Initiative [NABCI], 2010). In nearly all climate simulation models, mean temperatures in the Northern Great Plains could increase between 6.5 °F and 11.0 °F over the next 100 years (Ojima and Lackett, 2002). Without a substantial increase in precipitation to counteract the increased temperature, severe impacts such as decreased water inputs (precipitation and groundwater sources), decreased storage capacity, timing of recharge (change in hydroperiod), and frequency of drought are expected to occur (NABCI, 2010), resulting in more frequent drought conditions in the PPR, especially in the Dakotas and Saskatchewan (Johnson et al., 2005). Climate simulations show that a temperature increase of 3.6 °F could cause nearly two-thirds of the highly productive wetlands in the Dakotas and Saskatchewan to go dry (NABCI, 2010), likely causing shifts once more in the breeding range of waterfowl (Johnson et al., 2010; Johnson et al., 2005). However, the majority of wetlands in the eastern PPR that historically supported waterfowl have been drained for agriculture, so pothole wetlands and the birds that depend on them are acutely threatened in the north central states of the PPR (NABCI, 2010).

Today, the continental population of breeding grassland birds continues to decline at a very high rate compared to other bird guilds of North America. Fifty-four percent of species showed a significant negative trend between 1966 and 2010 (Sauer et al., 2011). Fifty-seven percent of grassland bird species also show a medium-to-high vulnerability to climate change (NABCI, 2010). This added pressure could result in more birds listed as Species of Conservation Concern. Higher temperatures predicted for the Great Plains (Ojima and Lackett, 2002) would decrease productivity in many grasslands (NABCI, 2010) due to changes in vegetation community and structure, loss of water sources, and decreased prey, among others. Native game birds such as the sharp-tailed grouse and greater prairie-chicken already are declining due to habitat fragmentation and native prairie loss. Because these birds are non-migratory and lack the ability to travel long distances, they may be unable to shift their distribution in the wake of climate change (NABCI, 2010). Finally, long distance migrants such as the bobolink and dickcissel may not be able to adapt quickly enough in response to effects of climate change (NABCI, 2010).

Wetlands and grasslands not only provide functional habitats for a wide variety of wildlife and plants, they also provide many ecosystem services for humans. Benefits of grasslands and wetlands include improving water quality, retaining floodwater, sequestering carbon, anchoring soil, capturing sediment and other contaminants, recharging groundwater, producing livestock, controlling exotic species and diseases, providing recreational opportunities, and more. Many of these benefits are lost every time grassland is plowed or a wetland is drained. This loss will only be accentuated as climate change progresses.

3.3 Biological Environment

Historical accounts from the settlement of Hamden Township in the 1870s describe “the grass in some places was two and a half feet high, the rolling prairie was dotted with lakes and groves here and there”; (Wilcox, 1907). More specifically, the area encompassed by the Hamden Slough NWR boundary, as depicted on the original General Land Office survey map, was an open prairie with abundant wetlands and lakes, including a large “impassable marsh” named Hamden Lake (figure 3-16). Historic vegetation communities were further described and mapped in 2012 by Heitmeyer et al. based on these historic documents, as well as information on geomorphology, soils, topography, and hydrology (table 3-1; figure 3-17).

The tallgrass prairie evolved under three ecological pressures (Anderson, 2006): grazing by herds of bison (Knapp et al., 1999), fire (Collins and Wallace, 1990), and a highly variable climate (Knapp and Smith, 2001). Specific to the Hamden Slough area, precipitation both as winter snows and summer rains varied annually as well as over decades, such as the Dust Bowl droughts of the 1930s or floods of recent years. This created a high level of variability in the number and persistence of wetlands. In drought years or periods, even the largest wetlands would dry out. However, dry periods actually allow wetlands to rejuvenate themselves. The prairie was and is a harsh place to live, with winter winds, summer sun and heat, herds of grazers, and fires. The wildlife and plants were adapted to these conditions. It wasn’t until European settlement that the prairie and its inhabitants would face the greatest threat to their existence.

Table 3-1: Historic Vegetation

Hydrogeomorphic (HGM) matrix of historic distribution of vegetation communities/habitat types on Hamden Slough NWR. Relationships were determined from old aerial photographs, plat and GLO maps, geomorphology maps, soil maps and survey publications, LIDAR topographic maps, various historical accounts of the region, botanical relationships, and land cover maps (Heitmeyer et al., 2012).

Habitat type	Geomorphic surface*	Soil type	Flood frequency
Mesic prairie	Moraine hill tops and high slopes	loam and sandy loam*	On-site precipitation
Wet mesic prairie	Lower moraine slopes, higher drainage edges	loam	On-site precipitation and surface/ground water discharge
Hill seeps	Seeps on moraine side slopes	Seeleville seep	Groundwater seeps
Wet meadow	Moraine drainages and high edges of wetlands and lakes	silt loam	Seasonal
Seasonal herbaceous marsh	Type I, II potholes and bands in deeper wetlands	silt clay loam	Seasonal
Persistent emergent marsh	Type III and IV potholes and deeper parts of glacial lakes	silt clay loam	Semi-permanent
Open water- aquatic	Deep zones in Type III and IV potholes and glacial lakes	silt clay loam	Semi-permanent to permanent

*Mesic prairie separated into sandy and non-sandy types based on soil type.

Figure 3-16: General Land Office Survey Map, circa 1870

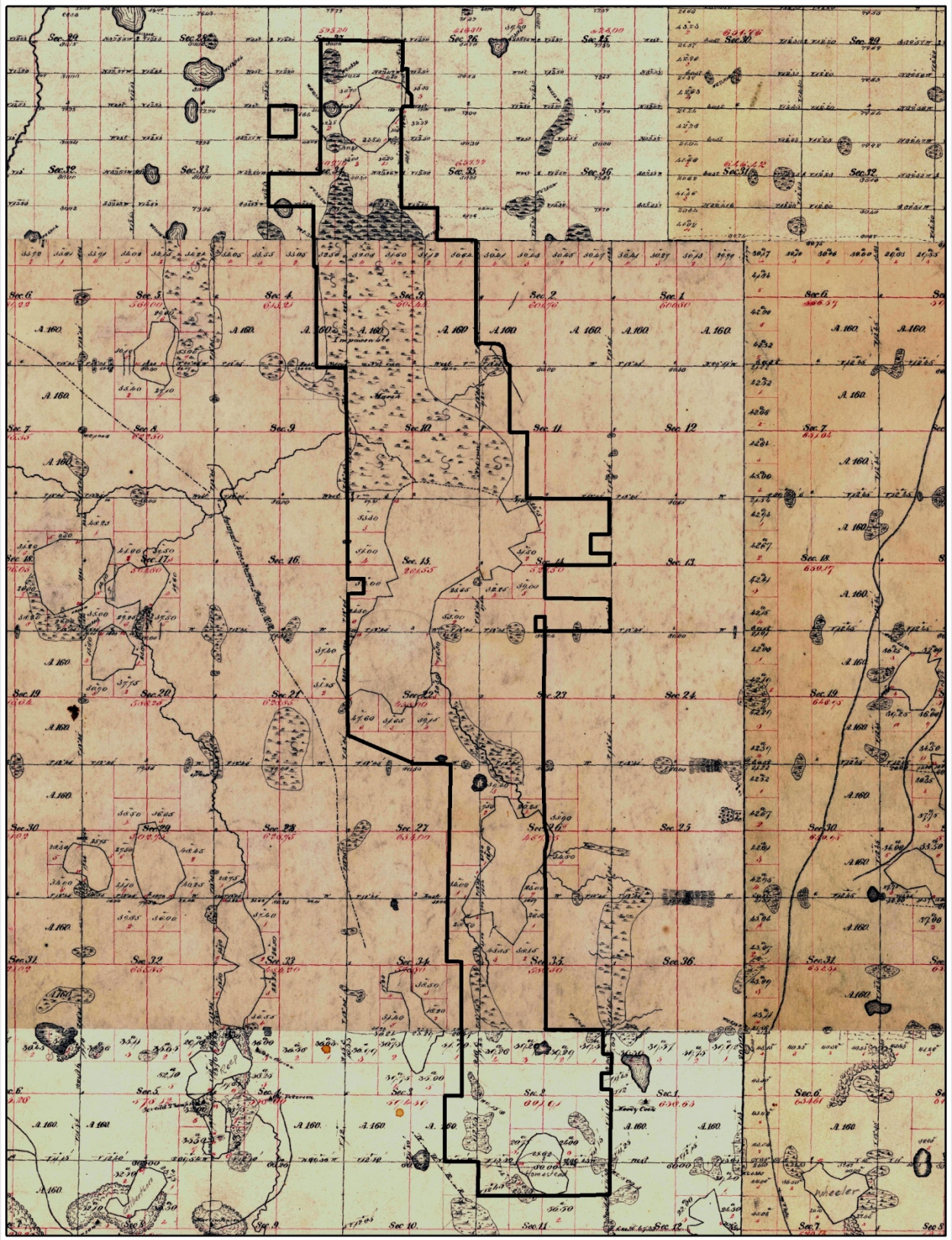
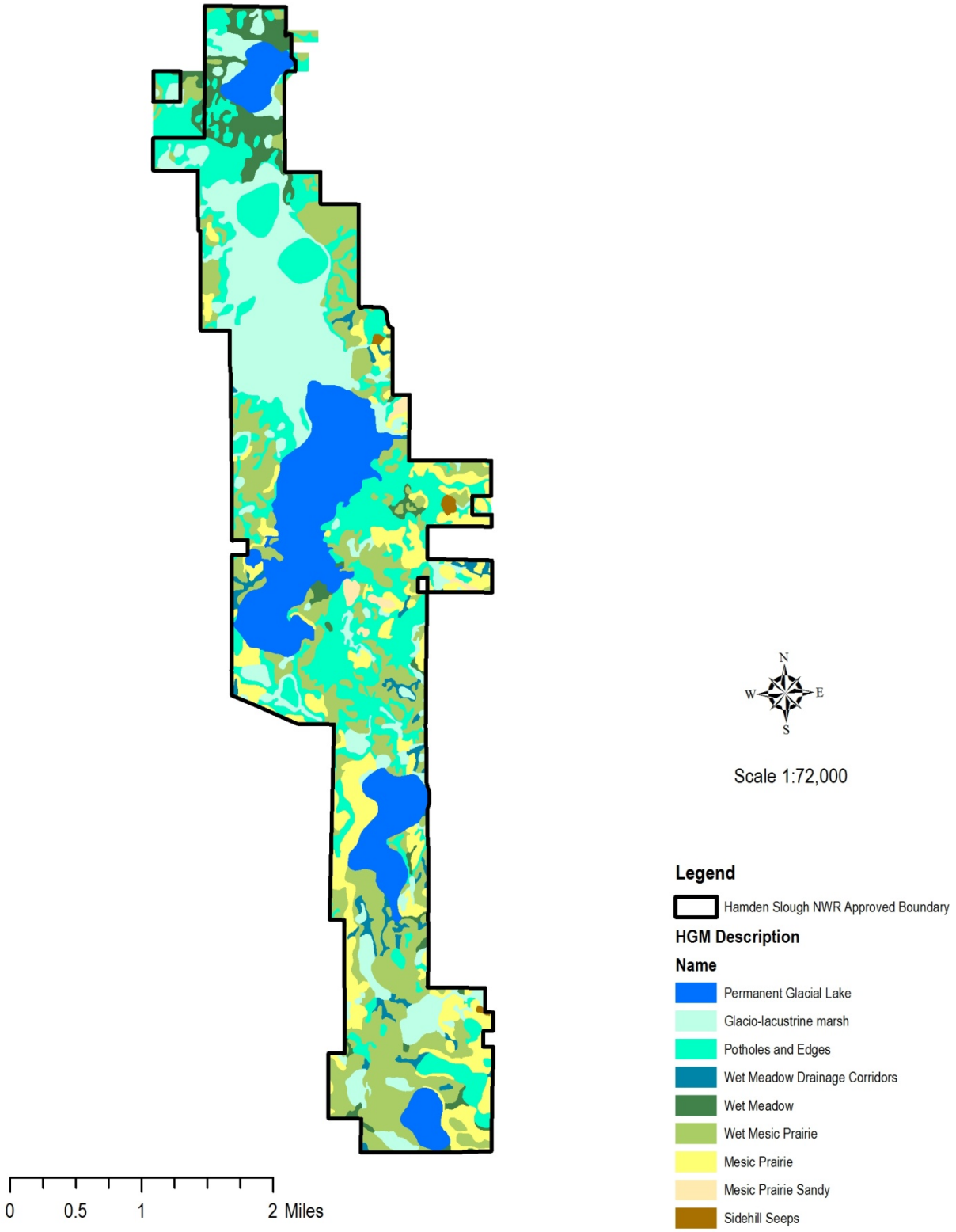


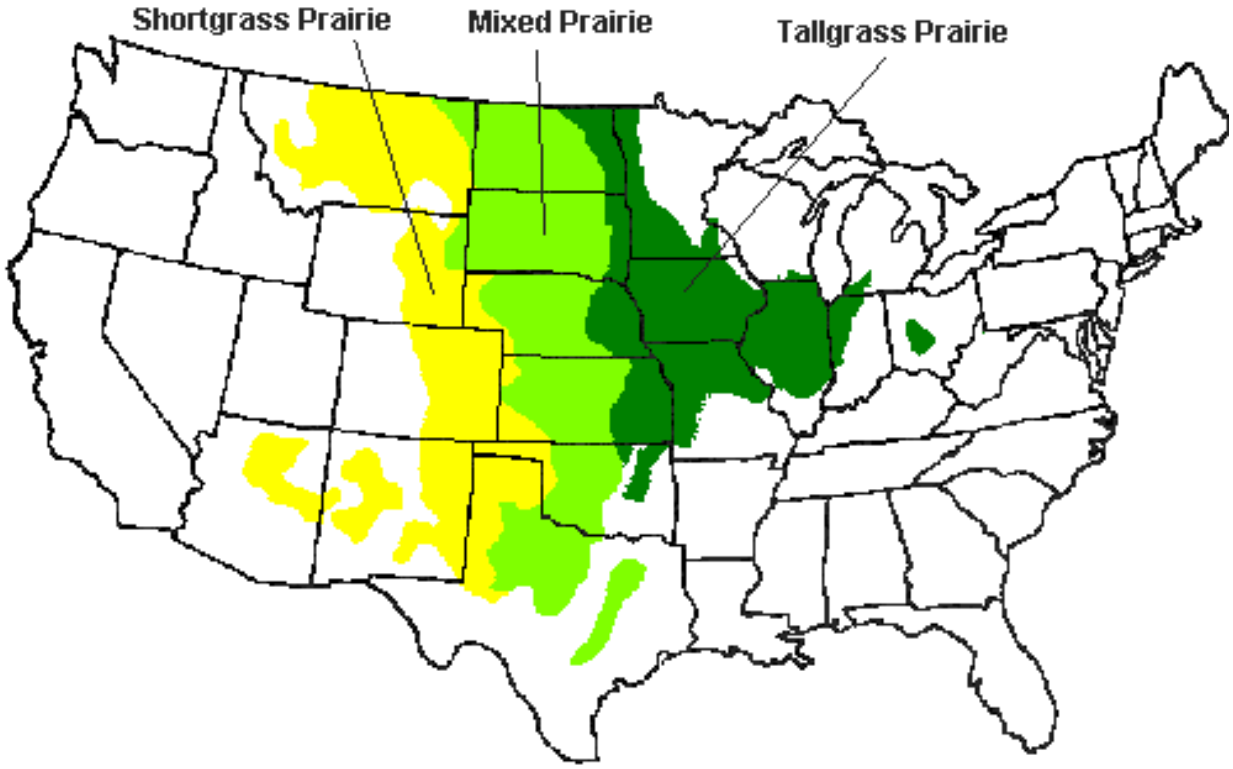
Figure 3-17: Historic Vegetation



Prairie Habitat

Hamden Slough NWR is at the northern end of the tallgrass prairie region, which forms a rough triangle from central Indiana to eastern Kansas to northwest Minnesota (figure 3-18, Transeau,1934). Tallgrass prairie is the easternmost and most productive of the three American grassland ecosystems because it receives much more rain than the short-grass steppe and mixed grass regions to the west. Tallgrass prairie is dominated by grasses and forbs (wildflowers), many of which are known for their extensive root systems (Weaver 1954). Approximately 90 percent of the biomass of the prairie is underground in the root systems. It is these roots that largely created the productive soils of the Midwestern cornbelt.

Figure 3-18: Tallgrass Prairie Region



Prairie plants can be divided into two groups: grasses and forbs. While grasses make up 90 percent or more of the biomass of the prairie, there are relatively few species. Forbs account for 90 percent or more of the diversity. Prairie grasses and forbs separate along moisture gradients. Given the topography and soils, most Hamden Slough NWR prairies probably were typical of the pre-settlement tallgrass prairies described as Northern Mesic Prairie (Minnesota DNR, 2005). Along the margins of wetlands and in wet-mesic prairies, prairie cordgrass (*Spartina pectinata*) is the dominant species.

Moving to more mesic soils, big bluestem (*Andropogon gerardii*), Indiangrass (*Sorgastrum nutans*), and switchgrass (*Panicum virgatum*), the characteristic species of the prairie, are dominant. On hilltops or in sandier soils, prairie dropseed (*Sporobolus heterolepsis*), little bluestem (Schizachyrium *scoparium*), porcupine grass (*Stipa spartea*) and side oats grama (*Bouteloua curtipendula*) are the most abundant grasses.

The diverse set of prairie forbs is dominated by two families: asters and legumes. These include asters *(Symphyotrichum spp),* blazingstars *(Liatris spp),* sunflowers *(Helianthus spp),* coneflowers *(Ratibida spp),* and goldenrods *(Solidago spp).* Legumes include prairie clovers *(Dalea spp)* and vetches *(Astragulus spp* and *Vicia spp).* Common woody shrubs include western snowberry *(Symphoricarpus occidentalis),* red osier dogwood *(Cornus sericea),* and wild plum *(Prunus spp).* Specific prairie assemblages representative of the area can be found in Refuge and District inventories (Pemble, 1995), scientific literature, and local knowledge.

Aster and legume species

Tallgrass prairie is a fire-dependent ecosystem (Collins and Wallace, 1990). The climate is actually wet enough to support trees (Briggs, 2005), but fire kept the trees in check and favored grasses (Leopold, 1949). Fire removes residual vegetation and litter layers, allowing seeds to germinate and new plants to become established. It also revitalizes the soil, building up nutrients important for flower and seed production. When fire is removed from the system, prairie is quickly converted to trees and forests (Heisler et al., 2003). The three questions surrounding historic fire regimes are: 1) what time of year were most fires, 2) how frequent were the fires, and 3) were the ignition sources lightning or human?

Most accounts from the historic literature show that fires in the tallgrass prairie region were most common in the fall (Wilcox, 1907; Higgins, 1986; McClain and Elzinga, 1994; Pyne, 1997), primarily the month of October. These same sources show that fires were quite frequent, with fires often referred to as “annual,” but not necessarily in the same location. Given the topography of the tallgrass prairie, Wright and Bailey (1980) suggest a fire frequency of five to ten years is reasonable. However, a more recent literature review suggests fire frequencies in the tallgrass region of Minnesota and Wisconsin were between two and three years but were highly dependent on the climate (Dickmann and Cleland, 2002).

While lightning is the primary source of ignition in western forests, lightning in the Midwest is usually accompanied by heavy rains. Lightning does cause fires in tallgrass prairie, but rarely. The vast majority of historic fires were set by indigenous people. The frequent records of October fires are during a time of the year when lightning storms are rare, lending more evidence that most fires were started by people. As Europeans settled the tallgrass prairie region, most fires were caused by locomotives and equipment used to clear the land, and fire frequencies remained high. By the 1920s, fire frequency and intensity waned as settlement increased and effective fire suppression programs began.

Grazing also is important to the maintenance of tallgrass prairie (Biondini et al., 1998). Bison were the primary grazers in western Minnesota, with deer and elk browsing on shrubs and young woody vegetation. Over 95 percent of the bison diet is grasses (Plumb and Dodd, 1993). Removal of these grasses releases the forb community from competition, dramatically increasing plant species diversity in grazed prairie (Hartnett et al., 1996; Towne et al., 2005). The increased plant diversity increases the diversity and abundance of invertebrates (Joern, 2005). Grazing creates a patchwork of vegetation structure from ungrazed to lightly grazed to heavily grazed areas. Patterns of standing vegetation affect fire pattern and behavior.

Fire and grazing interactions were important in the distribution of prairie vegetation communities across the landscape. Based on historical fire and grazing patterns, animals preferentially selected burned areas because of the young, green shoots and grazed them heavily. When another area burned, they moved to the newly burned patch. The interaction between fire and grazing created a shifting mosaic of microhabitats for grassland birds, prairie invertebrates, other wildlife, and vegetation.

As white settlers arrived in Becker County, they discovered a precious resource in the prairie—its soils. Soils were described for their richness, especially in the western portion of the county, “with no superior on the face of the globe” (Wilcox, 1907). This discovery ultimately led to the conversion of prairie to cropland in western Becker County, including the area of Hamden Slough NWR. Today, only about 22 acres of remnant prairie remain on the Refuge, all in small, highly fragmented parcels.

Wetland Habitat

The retreat of the Wisconsin glacier left approximately 25 million depressional wetlands of all shapes and sizes in the PPR. A variety of typical wetland types are found on Hamden Slough NWR, defined by soil type, duration of standing water, and vegetation communities. Some are fed by groundwater, but most are fed by rain and snowmelt. Temporary and seasonal wetlands, those that hold water for a few days to a couple months after thaw, make up the greatest number but the least acreage of the all wetland types. Semi-permanent and permanent wetlands, which typically hold water for an entire growing season or longer, are found at lesser densities but have the most surface acres of water (Stewart and Kantrud, 1971; Kantrud and Stewart, 1977). Each of the four types is described below (based on Cowardin et al.,1979).

Temporary wetlands only hold water for days or weeks, usually drying out by the start of the growing season. Most of the vegetation consists of annual plants that have adapted to the continually fluctuating and ultimately receding water levels. These plants begin to grow when the soils have little or no standing water. Some of the more common annuals found in temporary wetlands include beggarsticks (*Bidens spp*), smartweeds (*Polygonum spp*), barnyardgrass or wild millet (*Echinochloa muricata*), and weedy species such as common ragweed (*Ambrosia artemisiifolia*) and common cocklebur (*Xanthium strumarium*). Because of the high density of these wetlands during normal and wet years (Kantrud and Stewart, 1977), and the abundance of early aquatic invertebrates (Swanson, 1989), temporary wetlands provide important habitat for breeding waterfowl pairs (Kantrud and Stewart, 1977) and laying females (Swanson, 1989). Temporary (and seasonal) wetlands often are called “pair ponds.”

Intact or restored seasonal wetlands, which typically hold water throughout much of the growing season, provide the highest quality habitat for breeding waterfowl during years of average or above-average water conditions (Kantrud and Stewart, 1977). Seasonal wetlands also supply rich invertebrate food sources for laying hen waterfowl (Swanson and Duebbert, 1989), especially early in the spring when most of the larger wetlands are still ice-covered or warming up. Common vegetation includes some grasses: bulrush (*Scirpus spp*), sedges (*Carex spp*), spikerushes (*Eleocharis spp*), arrowhead (*Sagittaria spp*), and even cattail (*Typha spp*). In areas where water levels have receded, vegetation found in temporary wetlands may also be present.

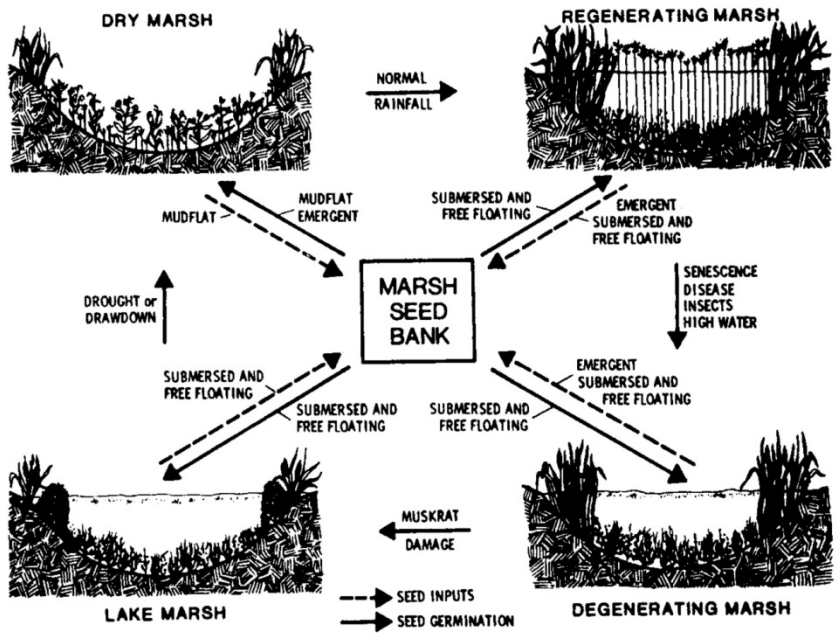
Semi-permanent wetlands hold up to three feet of water or more throughout the entire growing season. Because semi-permanent wetlands are productive season-long, they include some of the best breeding/brood marshes in the PPR, especially in dry years when temporary and seasonal wetlands go dry. Semi-permanent wetlands usually have a combination of robust, emergent vegetation such as cattails and bulrushes, and submerged vegetation important for invertebrate establishment. Examples of submerged vegetation include coontail (*Ceratophyllum demersum*), watermilfoil (*Myriophyllum verticillatum*), and pondweeds (*Potamogeton spp*). Hesby, Eagle, Hass, Office, South, and the Frog Pond are semi-permanent wetlands (Heitmeyer et al., 2012).

Permanent wetlands hold up to ten feet of water throughout the entire year. Usually they are dominated by open water and fringed by a border of emergent plants similar to those found in semi-permanent wetlands. Permanent wetlands are used as waterfowl brood marshes late in the breeding season when other wetland types have begun to dry out. During molt and fall migration, they provide important staging, resting, and feeding habitat for waterfowl. The relict glacial lakes of Hamden Slough NWR (Bisson, Homstad, Pierce, and Hamden) are classified as permanent wetlands (Heitmeyer et al., 2012) and also could be called “shallow lakes.”

Under natural conditions, wetlands of the PPR go through short- and long-term wet/dry cycles that vary with climate and drive nutrient cycling, vegetation growth, sediment oxidation, and invertebrate populations (Murkin, 1989). These cycles result in four distinct wetland distinct phases which are described below for prairie pothole wetlands (van der Valk and Davis, 1978) (figure 3-19).

During drought, the bottom of the wetland basin is exposed and conditions become suitable for annuals and perennials. This is referred to as the “dry marsh stage” when most use by wildlife is for cover or consumption of annual seeds. The regenerating marsh stage occurs when water returns to the basin. Annual plants are drowned out, returning nutrients to the wetland and providing food and habitat for invertebrates. Emergent plants continue to expand, water remains stable, and the wetland eventually enters the degenerative marsh stage. This typically is when “hemi-marsh” is reached—the equal interspersion or 50:50 ratio of open water and emergent vegetation (Weller and Spatcher, 1965). The wetland is at peak productivity and is used by the greatest diversity of wildlife due to abundant food and cover. Finally, as the wetland enters the lake marsh stage, only a ring of emergent vegetation, typically cattail, remains around the outside of the basin. Cover availability and invertebrate abundance and availability typically decrease except around basin edges. Wetlands stay in this stage until a drought begins the cycle once again (Van der Valk and Davis, 1978).

Figure 3-19: Wetland Phases



Wetlands of the PPR are extremely important to North American waterfowl populations. The availability of wetlands (Kantrud and Stewart, 1977) and distribution of emergent cover (Weller and Spatcher, 1965; Murkin et al., 1982) drive the numbers of breeding waterfowl in the PPR. Hemi-marsh (equal interspersion of open water and emergent vegetation) has been shown to support the greatest waterfowl breeding pair density and species diversity (Kaminski and Prince, 1981; Murkin et al., 1982) and can be present in seasonal and semi-permanent wetlands. While only 10 percent of the available waterfowl breeding habitat is found in the PPR, nearly 50 percent of waterfowl production occurs there. Historically, when the Dakotas and Saskatchewan experienced drought conditions, waterfowl shifted to the eastern and northern fringes of the PPR to breed, including the area of Hamden Slough NWR.

Many wetlands were drained for farming as settlers began making their livelihood in the PPR. Rudimentary drainage ditches were dug to release water from small temporary or seasonal basins. As

technology advanced, larger networks of surface ditches were created or subsurface tile installed to more efficiently drain all types of wetlands. Today, interconnected temporary, seasonal, and semi-permanent wetlands are drained into basins at lower elevations, which increases their water level and permanence; a process known as consolidation drainage (Krapu et al., 2004).

Consolidation drainage

Consolidation drainage changes the hydrology and chemistry of wetlands, favoring the establishment and proliferation of cattail (Kantrud, 1986c), sustaining introduced fish communities (Anteau 2011), and ultimately diminishing wetland quality for waterfowl breeding and brood rearing (Krapu et al., 2004, Anteau 2011) and shorebird foraging (Anteau 2011). This practice continues in force today. It is estimated that over 85 percent of wetlands in Minnesota's PPR have been lost to drainage (Johnson et al., 2008). However, more than 200 wetlands of all types have been restored on Hamden Slough NWR, adding to the important conservation role of the Refuge.

Wildlife and Fish Communities of the Prairie-Wetlands

Before European Settlement

One can only imagine what it was like living on the prairies of western Becker County in the early 1800s prior to the arrival of white settlers. Just like historical accounts from other areas of the Northern Great Plains, western Becker County was alive with large and small mammals, hundreds of species of birds, reptiles, amphibians, fish, and insects galore. But as prairies and wetlands were destroyed with the advancement of settlers, many wildlife and fish that depended on that habitat began to disappear, too.

The western part of Becker County, including the area of Hamden Slough NWR, was a favorite summer range of the buffalo (*Bison bison*), though their visits were not only confined to that season. While on his travels through western Becker County, Alvin H. Wilcox, an early surveyor, stumbled across many bison bones scattered in Hamden and Cuba townships. The last of the buffalo were seen in this area in the late 1860s. Elk (*Cervus elaphus*) was the other major mammal of the Hamden Slough area prior to settlement, likely browsing on shrubs in the prairie or tension zone between the prairies and woods. Elk left suddenly as Becker County was settled. Other mammals that likely roamed the prairies and wetlands of the Refuge were the prairie wolf or coyote (*Canis latrans*), moose (*Alces alces*), white-tailed deer (*Odocoileus virginianus*), jackrabbit (*Lepus townsendii*), badger (*Taxidea taxus*), pocket gopher (Geomyidae), muskrat (*Ondatra zibethicus*), jumping mouse (*Zapus hudsonius*), and the occasional antelope (*Antilocarpa americana*) among others (Wilcox, 1907).

However, it wasn't the mammals that defined Hamden Slough, it was the abundance birds. W.A. Wilkin, one of the first settlers of Hamden Township states, "Game was very plentiful, especially ducks, geese and prairie-chickens. It was no trouble to keep our families in meat, as all we had to do was to look out on the lake in the morning and see where the ducks were . . . and with a double-barreled shotgun, we could usually kill enough to last the whole day" (Wilcox, 1907). Waterfowl was probably the most plentiful of all the game due to the complex of wetlands and shallow lakes, including Hamden Lake. Other birds of interest recorded include whooping cranes (*Grus americana*), common moorhens (*Gallinula chloropus*), Eskimo curlews (*Numenius borealis*), and passenger pigeons (*Ectopistes migratorius)* near the town of Detroit in 1883 (Wilcox, 1907). Today, the passenger pigeon is extinct and it is likely the Eskimo curlew is too. Whooping cranes are a federally endangered species, and common moorhens rarely visit the area, with the last recorded sighting in 2003.

Donald P. Larson, a descendant of some of the early inhabitants of Hamden Lake wrote a historical account titled *The Hamden Slough and Lake Looked Like this 100 Years Ago*. His descriptions give a poignant perspective of life on Hamden Lake prior to major alterations of the land and resulting impacts to the area's wildlife.

The Hamden Slough and Lake Looked Like this 100 Years Ago

My grandfather (Sivert Larson) lived 6 miles north of Audubon. He built a log house where he and my grandma lived after they got married. He had seven sons and two daughters. My father's name was Peter. All the boys loved to hunt and fish. Hunting at that time was terrific! My father shot whooping cranes, swans and blue cranes. My uncle Max had an old 10 gauge shot gun and he sneaked down in the weeds and got 13 mallards with one shot!

My grandfather would go to Audubon and meet the train and pick up hunters from the cities and other towns around. He had two lumber wagons to haul the hunters out to the farm. If they had too much baggage they had to walk behind the wagon which was six miles. He had as many as 15 tents that they would set up on the east side of the grove. There was one problem though, he was very religious and would not let them hunt or fish on Sundays!

My other grandparents (Mr. and Mrs. Thorvald Erickson) lived on the east side of the lake. They had four girls and one boy. My mother's name was Clara. There was a spring fed creek that ran behind the barn and ran out to the lake. It had a very strong current. My mother used to take an old spool and tie a hook on to it and bait it and the current would take it down the creek. She used to catch Northerns that weighed 11 pounds! My uncle Elmer would trap all winter and sometimes my mother would go on skates to look at his trap lines if it wasn't too cold. In the spring he would have a whole triple wagon box of hides to sell. He would go and sell the hides in Lake Park.

My grandfather Sivert was against draining the lake. A government agency came around and said the water level was too low and they also said it was not healthy so he finally gave in. After the government agency got the ditch dug the government than turned around and charged him $4,000.00 ditch tax! My grandfather thought when God created lakes they should be left alone!

In the morning if it was still and a little foggy, my grandfather said you could hear the prairie chickens drumming, also the trumpet swans, whooping cranes, geese, loons and many species of ducks. He said it sounded like a symphony. In the fall if it was snowing you had to practically lay down so you wouldn't get hit by ducks coming in!

The log cabin Sivert built stood about 90 years. He built around it and on top so he had a big home when he got done. The house was tore down in 1972 which was the end of an era for the Larson family.

Hamden Slough Today

In 2004, Hamden Slough NWR was named an Important Bird Area (IBA) by Audubon Minnesota (National Audubon Society), one of the original IBAs in the state. Since the Refuge was established, over 200 species of birds have been recorded (see appendix C for species lists), including more than 20 species of shorebirds, nearly every major waterfowl species, and many grassland-dependent birds. This extraordinary result is likely due to the restoration of the prairie-wetland complexes located on Hamden Slough proper.

Marbled Godwit (Limosa fedoa)

The greatest number of shorebird species is observed during spring and fall migration. Over 17 species, including but not limited to, Hudsonian godwits (*Limosa haemastica*); white-rumped (*Calidris fuscicollis*), western (*Calidris mauri*), and pectoral (*Calidris melanotos*) sandpipers; short-billed dowitchers (*Limnodromus griseus*), and semi-palmated plovers (*Charadrius semipalmatus*), have been recorded. Only the marbled godwit (*Limosa fedoa*), greater yellowlegs (*Tringa melanoleuca*), and killdeer (*Charadrius vociferus*) are known shorebird breeders of Hamden Slough NWR. Marbled godwits are unique shorebirds attracted to wet prairies during the breeding season.

Canvasback (Aythya valisineria)

Waterfowl species, like shorebirds, are seen in large numbers during the spring and fall migrations. Snow goose (*Chen caerulescens*), American wigeon (*Anas americana*), northern pintail (*Anas acuta*), ring-necked duck (*Aythya collaris*), and common goldeneye (*Bucephala clangula*) are some of the migrants. Regular breeders include Canada geese (*Branta canadensis*), trumpeter swan (*Cygnus buccinator*), mallard (*Anas platyrhychos*), blue-winged teal (*Anas discors*), wood duck (*Aix sponsa*), and canvasback (*Aythya valisineria*), among others.

Additional species of interest drawn to the complex of wetland types on Hamden Slough NWR include American White Pelican (*Pelecanus erythrorhynchos*), Pied-billed Grebe (*Podilymbus podiceps*), Virginia Rail (*Rallus limicola*), Franklin's Gull (*Larus pipixcan*), Black Tern (*Chlidonias niger*), and American Bittern (*Botaurus lentiginosus*). Just about every niche of every wetland, from dense cattail to mudflats to open water, is utilized by waterbirds.

Similar to wetland birds, grassland birds responded to the addition of upland habitat when Hamden Slough NWR was established. Grassland birds of Hamden Slough NWR include, but are not limited to, bobolinks (*Dolichonyx oryzivorus*), clay-colored (*Spizella pallida*), grasshopper (*Ammodramus savannarum*), and field sparrows (*Spizella pusilla*); western meadowlarks (*Sturnella neglecta*), and northern harriers (*Circus cyaneus*).

Birds that frequent the wet margins between grasslands and wetlands are common yellowthroats (*Geothlypis trichas*), LeConte's sparrows (*Ammodramus leconteii*), sedge wrens (*Cistothorus patensis)* and savanna sparrows (*Passerculus sandwichensis*), among others.

Bobolink (Dolichonyx oryzivorus)

Short-eared Owl (Asio flammeus)

Portions of the Hamden Lake bottom are annually mowed, which attracts upland sandpipers (*Batramia longicauda*) and greater prairie-chickens (*Tympanuchus cupido*) for breeding and foraging activities. Short-eared owls (*Asio flammeus*) have also been observed in the Hamden lakebed.

While bison, elk, and antelope no longer exist naturally in this portion of Minnesota, many of the mammals common to western Minnesota grasslands and woodlots historically are still found on the Refuge today. These include white-tailed deer, coyote, badger, northern raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), mink (*Mustela vison*), muskrat, and a variety of small mammals. Mammals rarely seen that potentially use the Refuge are gray wolves and moose.

Amphibians and reptiles use Refuge wetlands for part or all of their life cycle, including the common eastern garter (*Thamnophis sirtalis*) and less common smooth green (*Liochlorophis* vernalis) snake; tiger (*Ambystoma tigrinum*) salamander; plains leopard (*Rana blari*), wood (*R. sylvatica*), and tree (*Hyla arborea*) frogs; northern spring peeper (*Pseudacris crucifer*); common snapping (*Chelydra serpentine*) and western painted (*Chrysemys picta*) turtles; and the 12-lined skink (*Eumeces fasciatus*). Historically, wetlands at Hamden Slough NWR did not contain sustainable fish populations because of winter freezing and interannual drying.

Although they are critical components of grassland and wetland habitats, information on invertebrate communities is lacking for Hamden Slough NWR. Aquatic and terrestrial invertebrates serve as an important food source for waterfowl, shorebirds, grassland birds, small mammals, reptiles, and amphibians. Invertebrates also consume plant and animal matter necessary for these systems to continue functioning. Finally, some prairie wildflowers are dependent on butterflies and other insects for pollination. Samples of aquatic invertebrates have been collected from Refuge wetlands although no complete inventories have been conducted. Some of the more common aquatic invertebrate collected during sampling were predaceous diving beetles, dragonfly and damselfly larvae, caddisfly larvae, backswimmers, and freshwater shrimp. Shrimp are important components of waterfowl diets, while dragonfly and damselfly larvae are consumed to a lesser extent. There are no known inventories of terrestrial insects on Hamden Slough NWR.

Priority Resources of Concern

The management direction of each refuge is driven first and foremost by a refuge's purpose(s) and statutory mandates, coupled with species and habitat priorities. The priorities that will guide wildlife and habitat management on Hamden Slough NWR can be found in appendix B. These priorities meet the migratory bird purposes of the Refuge and all Service mandates and policies including the Refuge Improvement Act. They were selected from a larger comprehensive list of Species of Concern (also found in appendix B) using the process detailed in *Identifying Refuge Resources of Concern and Management Priorities: A Handbook* (FWS, 2010).

Federal T&E Species

The Poweshiek skipperling (*Oarisma poweshiek*) was added as a candidate species in Minnesota, including Becker County, in October 2011. This moth-like butterfly is closely tied to high quality remnant prairie and therefore, is unlikely to inhabit Refuge remnants due to their small size and isolation. In addition, the Refuge's restored uplands contain few, if any, grasses and wildflowers critical to the larval and adult butterflies (e.g., little bluestem, side-oats grama, purple coneflower, and prairie lily). Larger, remnant prairie tracts do occur near the Refuge; however, it is unknown whether Poweshiek skipperlings occur in those locations.

In January 2012, the Service concluded that the gray wolf (*Canis lupus*) population was sufficient to no longer warrant protection under the federal Endangered Species Act and was delisted. The gray wolf is likely an uncommon visitor of Hamden Slough NWR. In 2009, a pack was observed on Buchl WPA, and again on Donley Tilman WPA in 2010; both WPAs are located four miles north of the northernmost portion of the Refuge.

State Species of Concern

One of the most prolific species of the NTGP, the greater prairie-chicken, is a species of concern in the state of Minnesota and a popular bird of Hamden Slough NWR. On the north end of the Refuge, there is a known lek located in a portion of the Hamden Lake bottom. The marbled godwit, a wet-prairie dependent bird of Hamden Slough NWR, is also a species of concern. Both birds use shorter grasses for foraging and breeding activities and nest in tallgrass sites on and off the Refuge. There are also many other state-listed species that have or could be found using the Refuge (see http://www.dnr.state.mn.us/rsg/index.html).

3.4 Socioeconomic Environment

Demographics

Hamden Slough NWR is located in Becker County in west central Minnesota, about forty miles east of the North Dakota border. The population of Becker County was 32,504 in the 2010 census, which is an 8.3 percent increase over 2000 numbers (U.S. Census Bureau, 2012). The Refuge lies seven miles northwest of the city of Detroit Lakes (county seat, population 8,570) and one mile from Audubon (population 520). Becker County has a total area of 1,315 square miles (841,600 acres); about 91 percent is terrestrial (primarily farm land and forests) and 9 percent is water (more than 400 lakes).

Nearly 90 percent of county residents are of European descent, primarily German and Norwegian; about 7.5 percent are Native American. About 31 percent of residents are under the age of 18, and 17 percent are over 65 years of age. The county has four school districts associated with the communities of Detroit Lakes, Lake Park-Audubon, Frazee-Vergas, and Pine Point. Ninety percent of the population 25 years or older has attained at least a high school level of education; 21 percent has a Bachelor's degree or higher (U.S. Census Bureau, 2012).

Becker County has more than 18,000 housing units, with nearly 25 percent used only seasonally, occasionally, or for recreational uses. Median value of owner-occupied housing units is $166,800 (U.S. Census Bureau, 2012).

Income, Employment, and Local Economy

Median household income in Becker County is just over $46,000; about 11 percent of the population has income below the poverty line. The five-year estimate (2006–2010) of unemployment is 5.3 percent. Private non-farm employment decreased between 2000 and 2009 by 28 percent (U.S. Census Bureau, 2012).

About 75 percent of workers are private wage and salary earners, another 14 percent work for the government, and 11 percent are self-employed. Employment sectors and percentages in the county include:

- 29 percent – management, business, science, and arts
- 25 percent – sales and office
- 17 percent – service
- 13 percent – natural resources, construction, and maintenance
- 16 percent – production, transportation, and material moving

Agriculture
In 2007, Becker County had 1,202 farms totaling nearly 400,000 acres. Total market value of products sold was $150 million, about evenly divided between crops and livestock/poultry. Crops included about 70,000 acres of soybeans, 46,000 acres of wheat, 38,000 acres of corn, and 8,300 acres of sugar beets. Another 37,000 acres were classified as forage (land used for hay and haylage, grass silage, and green chop). Net income averaged $40,137 per farm. Sixty percent of operators had a primary occupation other than farming (USDA, 2007).

Tourism
In 2009, the leisure and hospitality industry generated about $62.6 million in gross sales in Becker County and supported 1,310 jobs, contributing $4 million in sales tax to the state economy (Explore Minnesota Tourism, 2011). The region offers visitors water-based recreation, cultural attractions, and multiple festivals and special events.

In 2007, the University of Minnesota's Tourism Center published the results of a survey of visitors to the Detroit Lakes-Mahnomen area (Salk and Schneider, 2007). The study was designed to inform tourism planning and development and subsequently enhance visitor experiences and destination revenue. Nearly 90 percent of respondents identified their primary destination as Detroit Lakes, 36 percent were traveling for pleasure or recreation, over half had traveled less than 100 miles, and 85 percent were repeat visitors. Visitors indicated that nature-based opportunities were important to their destination choices. Among the top ten most important features, six were nature-based, although approximately one-third or fewer of visitors experienced or participated in nature-based activities during their trip. Reasons for this could include a lack of awareness or a lack of time. The report noted that additional attention to nature-based opportunities could benefit the local economy.

3.5 Historical and Cultural Resources

Area History

Prehistoric
The Refuge landscape is the product of a long and complex series of climatic changes and glaciations. The final retreat of the Red River Lobe of the Laurentide Ice Sheet occurred during the late Pleistocene Epoch approximately 12,000 years ago, forming the large glacial Lake Agassiz. The Red River Drainage was not accessible to human settlement until the recession of Lake Agassiz started around 11,500 before the present (BP) and was not fully accessible until at least 9,500 BP. The Hamden Slough NWR area conceivably could have been used by Paleo-Indian hunter/gatherers during this period (Ward et al., 1997).

The Archaic Tradition (8,000 to 4,000 BP) generally is characterized by the development of efficient hunting and gathering cultures and greater exploitation of local environments for food and tools. The large mammals of the Pleistocene Epoch (mammoth, horse, camel, etc.) were by then extinct and environmental conditions had largely stabilized. Increasing regionalization occurred throughout the Archaic that appears to be linked in part to major biomes (e.g., prairie, deciduous forest, lake-forest).

Native populations apparently increased dramatically from 4,000 to 1,500 BP during the Woodland period. Increases were related to rapid diffusion of techniques for obtaining, storing, and processing food. This late-Prehistoric period was a time of lake-focused subsistence settlement in the Hamden Slough and receding Lake Agassiz region and included semi-permanent villages, many of which were fortified, and gardens used for active plant production (Heitmeyer, 2012).

Historic
The Cheyenne were the first known historic Native American group to live in the upper reaches of the Red River Valley. The Cheyenne were decimated by smallpox during the early 1780's, leaving the upper Red River Valley open for the Ojibwe who became the dominant people in the region until the mid-1800s. The Eastern Dakota, Teton, and/or Yankton people were present in the lower reaches of the Red River

Drainage when the first Euro-American explorers arrived. Available evidence indicates that Eastern Dakota people occupied most of the lake-forest biome of central and northern Minnesota.

Pierre Gaultier de Varnennes Sieur de LaVerendrye, a fur trader and explorer for the French government, was the first European in the Hamden Slough NWR region in 1731. At the end of the French and Indian War in 1763, the French abandoned fur trading activities in the Red River Valley to British- and American-born traders. The British regime ended with the purchase of the Louisiana Territory by the United States in 1803. The period between 1803 and 1837 was characterized by the exploration and mapping of the region. The first land cession by the southern Ojibwe was made in 1837. Multiple treaties with the Ojibwe, Dakota, and Winnebago tribes soon opened up central Minnesota to logging and settlement.

The first permanent white settlers arrived in the Hamden Slough region in 1871 in association with construction of the Northern Pacific Railway. This line stimulated tremendous population growth as well as the founding of four towns in southwestern Becker County: Detroit Lakes, Frazee, Audubon, and Lake Park. The Soo Railroad was constructed on a north-south line through Detroit Lakes in 1903; it lies just east of Hamden Slough NWR. Detroit Lakes developed into an important agricultural market center. The railroads also brought tourists to the area, attracted by prime hunting, fishing, and recreational opportunities. By 1923 Becker County had a population of nearly 23,000 people.

Refuge Cultural Resources

The presence of prehistoric cultural artifacts in this region of Minnesota is light and can only be expected in areas with specific defining characteristics such as high relative elevation, the banks of waterways and large lakes, and the beach ridges of glacial Lake Agassiz. The Indian Springs Site is the only known prehistoric site within the authorized Refuge boundary. It was discovered during the 1997 cultural resources survey (Ward et al., 1997). Three working basalt tools were found, but a period of occupation could not be pinpointed. Avoidance of the area was recommended to prevent disturbance.

Ward et al. (1997) also determined that a total of 12 historic farmsteads or other historic sites could be located within the authorized Refuge boundary. These rural residential/agricultural complexes date back as far as 1875. Only one standing structure—a farm outbuilding—was identified. Due to absence of the farm house and significant structural instability, the structure was thought to be ineligible for the National Register of Historic Places. Sheet midden deposits associated with the structural complexes are relatively light, but the presence of shaft features (wells and privy pits) is nearly certain.

The north end of Hamden Slough NWR encompasses a portion of the White Earth Reservation. Through consultation with the White Earth Band of Ojibwe, no known traditional cultural properties have been identified on the Refuge. Other tribes associated with the region such as the Red Lake, Upper and Lower Sioux, and Cheyenne have not indicated any knowledge or expectation of traditional cultural areas on the Refuge.

Cultural Resources Management

Cultural resources (archaeological sites, historic structures, and Native American traditional cultural properties) are important parts of the nation's heritage. The Service strives to preserve evidence of these human occupations, which can provide valuable information regarding interactions between individuals, as well as between early peoples and the natural environment. Protection of cultural resources is accomplished in conjunction with the Service's mandate to protect fish, wildlife, and plant resources.

The Service is charged with the responsibility, under Section 106 of the National Historic Preservation Act of 1966, of identifying historic properties (cultural resources that are potentially eligible for listing on the National Register of Historic Places) that may be affected by Service actions. The Service is also required to coordinate these actions with the State Historic Preservation Office, Native American tribal governments, local governments, and other interested parties. Cultural resource management in the Service is the responsibility of the Regional Director and is not delegated for the Section 106 process

when historic properties could be affected by Service undertakings, for issuing archaeological permits, and for tribal involvement.

The Archaeological Resources Protection Act of 1979 (ARPA) Section 14 requires plans to survey lands and a schedule for surveying lands with “the most scientifically valuable archaeological resources.” This Act also affords protection to all archeological and historic sites more than 100 years old (not just sites meeting the criteria for the National Register) on federal land and requires archeological investigations on federal land be performed in the public interest by qualified persons.

The Regional Historic Preservation Officer (RHPO) advises the Regional Director about procedures, compliance, and implementation of these and other cultural resource laws. The actual determinations relating to cultural resources are to be made by the RHPO for undertakings on Service fee title lands and for undertakings funded in whole or in part under the direct or indirect jurisdiction of the Service, including those carried out by or on behalf of the Service; those carried out with federal financial assistance; and those requiring a federal permit, license, or approval.

The responsibility of the Refuge Manager is to identify undertakings that could affect cultural resources and coordinate the subsequent review process as early as possible with the RHPO and state, tribal, and local officials. Also, the Refuge Manager assists the RHPO by protecting archeological sites and historic properties on Service managed and administered lands, by monitoring archaeological investigations by contractors and permittees and by reporting ARPA violations.

3.6 Current Refuge Programs

Hamden Slough NWR is a relatively new refuge and many of the programs are still evolving and expanding. The Refuge never has had a large staff. In the beginning, three dedicated staff built the Refuge from the ground up and managed all programs. Currently, with decreased budgets, no Refuge staff, and an incomplete boundary limiting further restoration and management options, the programs have endured change. But regardless of change, the goal is to maintain a balanced and functioning prairie-wetland landscape that meets the collective needs of both wildlife and people in a sustainable way.

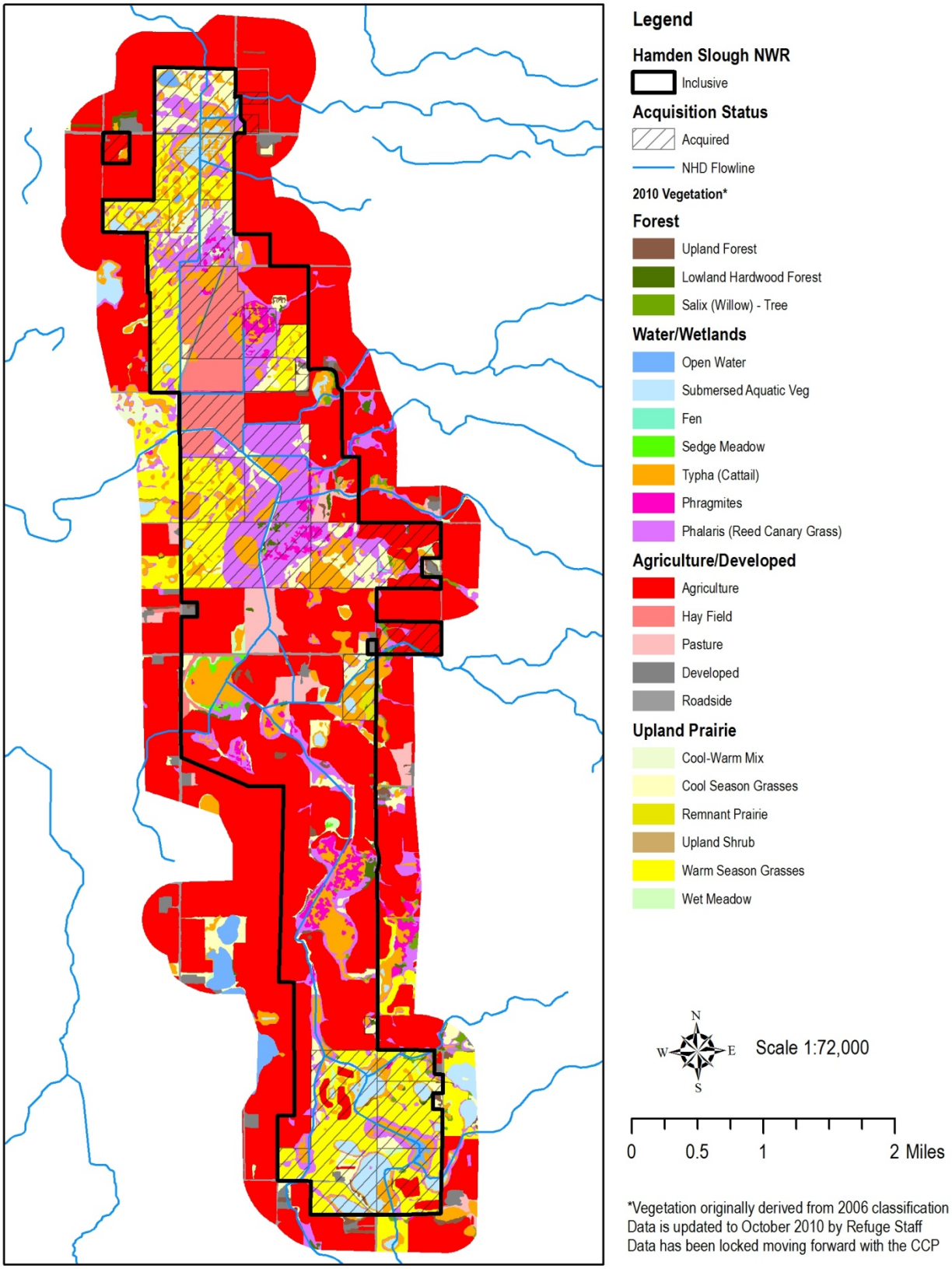
Biological

Currently, most of the Refuge is composed of planted grasslands, drained lakebed, and restored wetlands; while trees, remnant prairie, and food plots make up a small percentage of fee land (figure 3-20). The biological programs of Hamden Slough NWR have a rich and varied history.
A Concept Plan was developed for Hamden Slough NWR in the early 1990s to provide initial restoration and management guidance for the newly established Refuge. The biological program emphasized management for migratory waterfowl (especially breeding ducks) and resident wildlife (especially furbearers, ground-nesting birds, and white-tailed deer).

As land was acquired, a primary focus was providing wetland habitat by using ditch plugs, dikes, and water control structures to restore drained wetlands and facilitate water level management. Uplands were planted to a mixture of grasses to provide nesting habitat for migratory waterfowl and resident prairie-chicken, pheasant, and grey partridge. Some fields were kept as cropland to provide food for Canada geese, migrating ducks, deer, prairie-chickens, and pheasants. Numerous waterfowl nesting islands and structures were planned, as well as a predator management program.

During the past 20 years, some aspects of the Refuge biological programs have been modified in response to changing conditions. The landscape has undergone changes that affect wildlife and habitat, new threats to the Refuge are emerging, new laws and policies have been put in place, and new scientific data are available. This CCP redefines future management direction and priorities based on updated information. It is the first comprehensive planning effort undertaken for Hamden Slough NWR since the Concept Plan was developed.

Figure 3-20: Current Vegetation



Because of extensive wetland and upland restorations, evolving management and monitoring techniques, and guidance provided by recent assessments of Refuge resources (CAP, WRIA, and HGM), Hamden Slough NWR will continue to be capable of supporting a diversity of migratory birds, and other native wildlife and plants for future generations.

Wetland Restoration and Management

The landscape of Hamden Slough NWR has been highly altered for agricultural production. Many ditches have been constructed to aid in wetland drainage. The Ditch 15 system was constructed in the early 1900s and is still maintained today. Approximately ten miles of the Ditch 15 system lie within the approved Refuge boundary; six miles of which are located on acquired Refuge property (Newman and Eash, 2011). Additional unnamed intermittent streams and smaller surface ditches are also located within the approved boundary, including Refuge fee land. When large ditch systems were built, the spoil probably was placed outside and along the ditch, sloughing off into the waterway. When small surface ditches were dug or scraped, the spoil often was placed in the wetland bottom, filling it with sediment. A large number of wetlands were restored during the first 20 years of Hamden Slough NWR's existence.

Between 1991 and 2002, more than 200 temporary and seasonal wetlands, the most "at-risk" wetlands of the PPR, were restored (table 3-2). Most were restored by scraping sediment deposits from the basin bottom and using it to construct ditch plugs to hold back water. The remaining fill was spread on adjacent uplands. Some of the small surface ditches were never filled, so natural hydrology of the wetland was not fully restored and water movement is likely impeded today. As techniques evolved, wetlands were restored by scraping the sediments and completely filling in the surface ditches that drained them, restoring not only the wetland but also the hydrology.

Table 3-2: Pothole Restorations

Year	Tract Name/#	Pothole Wetlands	Wetland Acres
1991	Spring Marshes	29	16.3
1991	Hass #32	4	8.2
1992	Elleson/S Unit	5	8.5
1996-1997	Hass #32	11	4.2
1996	S Unit #10,11,12	21	7.5
1997	Amundson #43	15	10.2
1997	near Hamden Lake	1	37
1998	Scherzer W #45	2	4.8
1998	Scherzer E #45	14	6.1
1998	Amundson N #43	23	9
1998	Flottemesch #44	14	7.2
1998	Matter #41	22	8.1
1998	Unknown	6	3.3
1999	Unknown	22	8.1
1999	Zurn #42	2	13.6
2000	Zurn #42	18	4.2
2002	Matter #37	19	5.4
Total		**228**	**161.7**

Two major wetland restoration projects, the "Big 6" and the "North Star 2000," added significant semi-permanent and permanent wetland habitat back to the Refuge (table 3-3). These larger, managed

wetlands were restored with surface water inlets and outlets, receiving and discharging most of their source water from and back into the ditch system or its tributaries.

Table 3-3: Managed Wetlands

Water Feature Name	Type of Surface Water	Extent (Full Pool/River miles)	Elevation (Full Pool)	Volume (FP)	Remarks
Ditch 15	Ditch/Canal	6 mi	NA	NA	County ditch system. Ten miles total within acquisition boundary
Unnamed Tributaries/					
Ditches	Stream/river				
Ditch/canal	4.5 mi	NA	NA	Multiple unnamed intermittent tributaries are located on the Refuge; approximately 12 tributaries spanning 8 mi within total acquisition boundary.	
Office Wetland	Wetland, Managed	10.3 ac.	1263.0 ft.	29.4 ac. ft.	Emergent Wetland
Hass Wetland	Wetland, Managed	12.0 ac.	1260.0 ft.	26.0 ac. ft.	Emergent Wetland
Homstad Lake	Wetland, Managed	71.3 ac.	1260.0 ft.	238 ac. ft.	Open Water Wetland
Hesby Wetland	Wetland, Managed	60.9 ac.	1258.0 ft.	233 ac. ft.	Open Water Wetland
Eagle Pond	Wetland, Managed	43.5 ac.	1252.0 ft.	124 ac. ft.	Open Water Wetland
South Wetland	Wetland, Managed	20.1 ac.	1262.0 ft.	49.0 ac. ft.	Emergent Wetland
Bisson Lake	Wetland, Managed	112 acre	1231.5 ft.	110 ac. ft.	Emergent Wetland
East Frog Pond	Wetland, Managed	13.7 ac.	Unknown	Unknown	Emergent Wetland
West Frog Pond	Wetland, Managed	9.9 ac.	Unknown	Unknown	Emergent Wetland

Restoration of the Big 6 wetlands was completed in 1995 after years of gathering data, cost-estimates, permits, and agreements. Ducks Unlimited (DU), the Izaak Walton League, Safari Club International, and the BRRWD were key partners. The Big 6 wetlands (Haas, Homstad, Office, South, Hesby, and Eagle), neighboring wetlands on Anderson WPA, and private land form a large, interconnected complex in Sections 1 and 2 of Audubon Township. Water enters the complex from the south, east, and west and flows north, exiting Eagle pond onto private land via Ditch 15. Water control structures with stoplogs were installed to facilitate water level manipulation.

There are limitations, however, to water management capabilities, and it is not always possible to achieve intended levels given certain situations upstream. Large rain events or structure deficiencies can cause water to flow in places it wasn't originally intended. Therefore, due to the interconnectivity of the Big 6, it is critical to consider all pool levels when planning, as well as conditions within the greater watershed.

In the end, Hamden Slough NWR regained 218 surface acres of water on the south end, all with management capabilities to attract and support a variety of wetland wildlife throughout the year (figure 3-21).

Figure 3-21: Big 6 Wetland Restoration

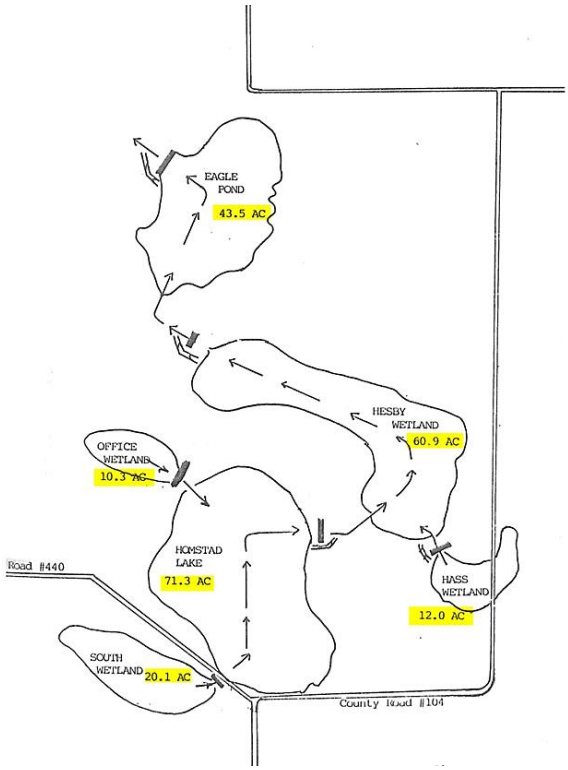
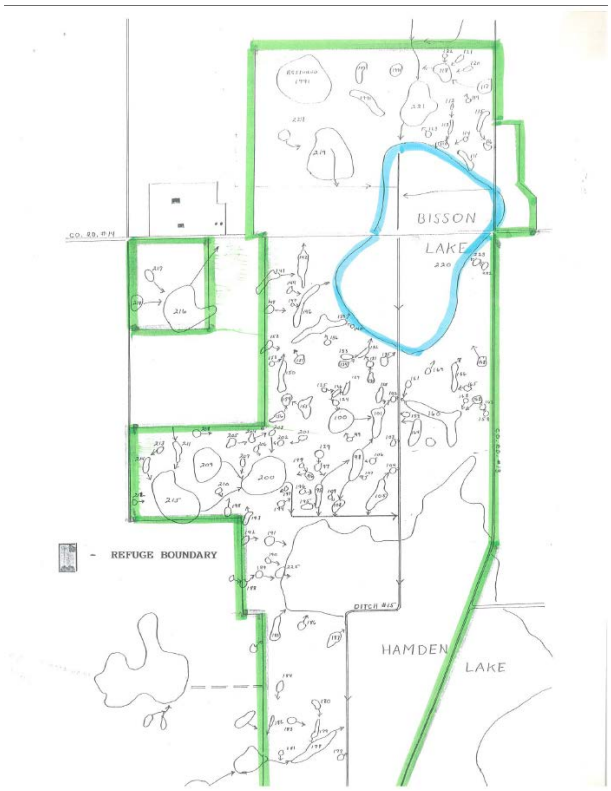


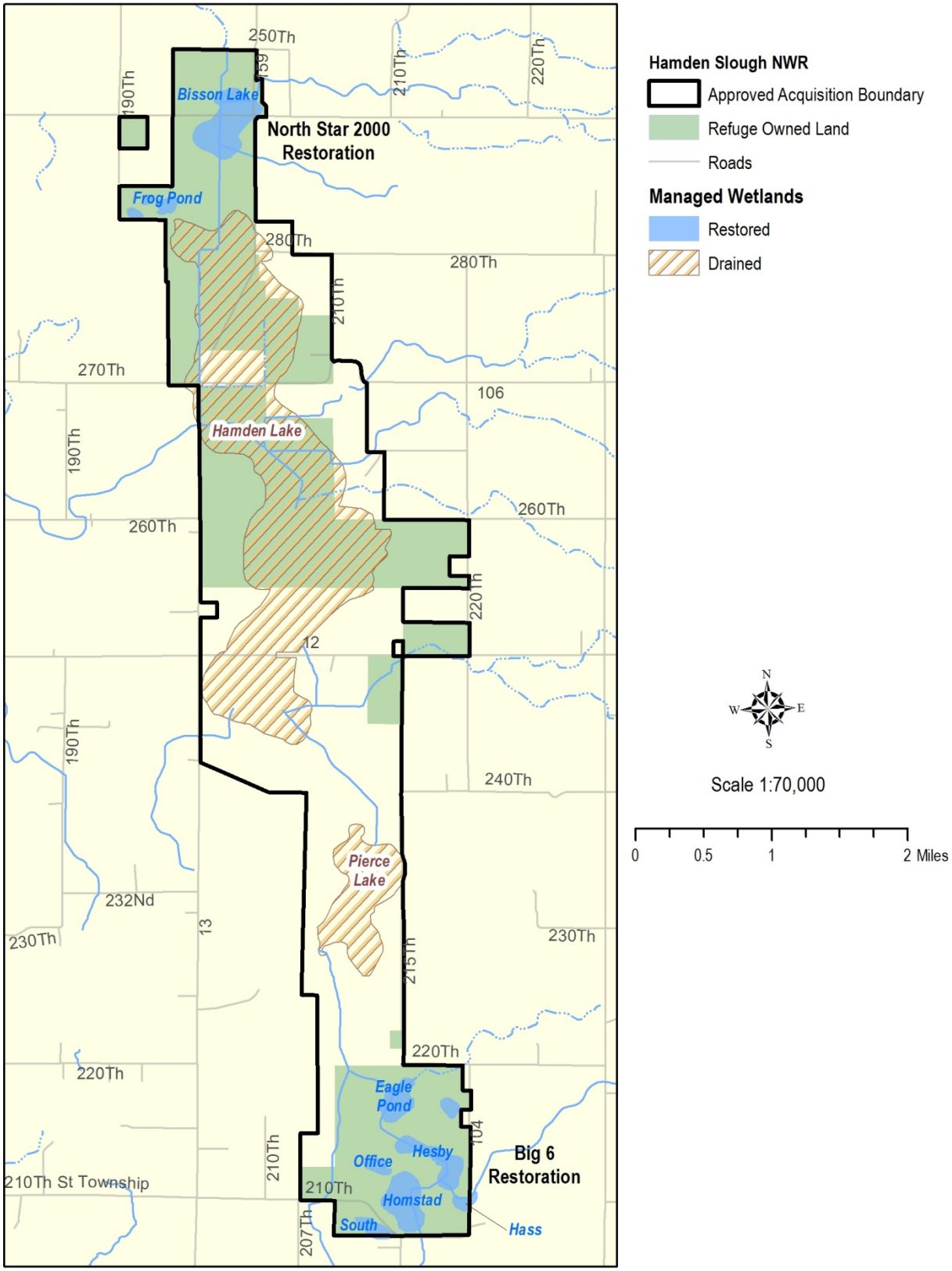
Figure 3-22: North Star 2000 Wetland Restoration



The goal of North Star 2000, the flagship project of DU at the time, was to restore 220 wetlands and 965 upland acres on the Refuge and surrounding state and federal lands by the close of the millennium. The project centerpiece was restoration of Bisson Lake, a 112-acre permanent wetland on the northern end of the Refuge (figure 3-22), along with two semi-permanent wetlands known as Frog Pond East and West (approximately six acres each). All three had been drained by construction of Ditch 15 and its laterals. However, prior to restoration, during spring melt when ice blocked the ditches, water pooled in the drained basin and attracted thousands of migrating waterfowl, which illustrated Bisson Lake's importance.

The *partial* restoration of Bisson Lake was completed in 2000. Historically, the water backed farther northwest and southeast into marsh, pothole wetlands, and edge habitats. If the complex was restored fully, the water would not only impact the adjacent private land, but would also overtop Becker County Highway 14. Currently, the Service has agreed to hold the water at a reduced "full" pool, with water only partially covering the historic lake-portion of the wetland complex to avoid impacts to the county road base. A flood easement was acquired from the landowner east of Bisson to allow saturation when managed at full service level or full pool. In addition to DU, other Partners that contributed to the restoration of Bisson Lake and associated habitat were the BRRWD, the Red River Water Management Board, the Minnesota DNR, and the National Fish and Wildlife Foundation.

Figure 3-23: Managed Wetlands



Two significant water bodies within the approved Refuge boundary remain drained today: Hamden Lake and Pierce Lake (figure 3-23). The original land survey maps describe the area as being open prairie with abundant wetlands and lakes, including a large “impassable marsh” named Hamden Lake. The size of Hamden Lake, which included both open water and marsh habitat, is estimated to be more than 1,500 acres or one-quarter of the entire Refuge after complete acquisition. Hamden Lake was known for an abundance of waterbirds during pre-settlement and early settlement times (see Donald P. Larson’s account, earlier in this chapter under “Before European Settlement”). The Service owns the majority of the lake; however, key portions needed for complete restoration are still in private ownership. Pierce Lake currently is under private ownership and when restored, is estimated to be nearly 200 acres. Pierce Lake lies southeast of Hamden Lake and must be restored first due to the connection between the two water bodies. If Hamden Lake were restored first, water would back into Pierce Lake preventing restoration. With the restoration of both these lakes, Hamden Slough NWR could once again serve as a major breeding and stopover area for thousands of waterbirds, rivaling its pre-settlement state.

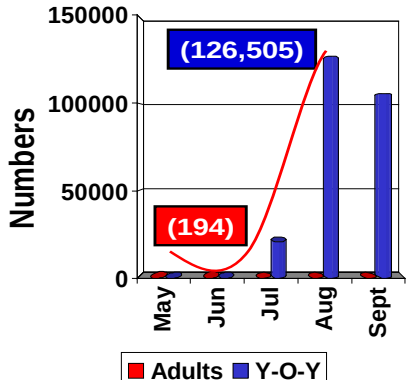
Cattail ring around Hesby Wetland

An annual water level management plan is developed based on the previous year’s climate, emergent vegetation cover, extent of hybrid cattail or other invasive species, and wildlife needs. However, because water levels can fluctuate depending on precipitation and other unforeseen events (i.e., beaver dam, structure damage, etc.), the management plan is flexible. Currently, most management is conducted to benefit migrating and breeding waterfowl and shorebirds, but human benefits are also considered. In late winter/early spring when ice conditions allow, most wetlands are drawn down to collect spring runoff. Water levels may be held high for a period of time to help alleviate downstream flooding. Water levels are typically drawn down again to provide mudflats for shorebirds during spring migration. Levels are brought back up again at the end of shorebird migration for quality waterfowl breeding and brood habitat. Some levels may be dropped again in late summer for shorebirds on their way back south. Some wetlands are kept fairly high overwinter to benefit species that depend on substantial water levels to survive through the winter, while others are kept at a lower level to protect roadsides through the frost-thaw cycle in early spring. Although water level management occurs annually, different wetlands receive different treatments depending on desired outcomes.

Emergent vegetation is important to wetland productivity, providing cover for many wetland-dependent birds, habitat for invertebrates, and a critical food source for many bird species. Many Refuge wetlands have either too much or too little emergent vegetation. Water levels are sometimes dropped to expose soil and promote seed germination of emergent plants such as sedges, cattail, and rushes. The highest waterfowl breeding pair density and species diversity is found in wetlands under the hemi-marsh conditions (Kaminski and Prince, 1981; Murkin et al., 1982). Hybrid cattail, an aggressive invasive emergent, forms dense stands when conditions are right and can become established during drawdowns. In addition, when wetlands are in the “lake marsh phase” for prolonged periods of time, cattail will also form around the wetland edge.

Most vegetation management on the Refuge is to reduce stands of hybrid cattail. Water level management to control cattails usually is done in conjunction with mechanical treatment. When cattail stands become too widespread and dense, water typically is drawn down in fall after migration and the cattail is cut over the ice. Water is held at full service level the following year to drown out the cut cattail and new shoots. Where water level management is limited (e.g., Bisson Lake), aquatic application of glyphosate has been used to control cattail advances.

Figure 3-24: Fathead Minnow Fecundity Rates



From Payer and Scalet, 1978

Invasive fish species, such as fathead minnows (*Pimephales promelas*), brook sticklebacks (*Culaea inconstans*) and roughfish, are another potential problem in Refuge wetlands. Fathead minnows seem to be of most concern because they have a very high fecundity (reproduction) rate (Payer and Scalet, 1979) (figure 3-24) and compete with ducklings and other wetland-dependent wildlife for invertebrate foods. Often, due to high rain events, minnows actually can travel overland from wetland to wetland in water sheetflow. As a means of getting rid of baitfish, minnows also are dumped into wetlands that are easily accessible from roads. In addition, with consolidated drainage via surface ditches or tile, minnows have the ability to move from smaller to larger water bodies with little problem. Water level management is used quite often to rid a basin of invasive fish by drying out the wetland in summer or creating anoxic (no oxygen) conditions in the winter. Complete drawdown of wetlands has occurred on Hamden Slough NWR in the past for invasive species control and to mimic the wet-dry cycle. However, this strategy is currently not considered in the annual water management plans.

Refuge pothole wetlands receive little, if any, direct management because they lack water control structures. Instead, pothole wetlands rely on nature to determine the wetland phase and thus, the amount of water and wetland vegetation species and distribution. Many wetlands on the Refuge currently contain open water surrounded by a ring of cattail (lake phase), possibly due to a combination of factors including consolidated drainage and the recent 15-year wet cycle. One way to indirectly manage pothole wetland vegetation is through management of the adjacent uplands using grazing, haying, or prescribed fire. Whether the wetlands receive that disturbance or not depends on factors such as soil moisture, amount of standing water, and time of year.

Upland Restoration and Management

Restoration

Only 20 acres of remnant tallgrass prairie exist on the Refuge in small, fragmented pieces; most locations are unknown to current staff. The majority of the land acquired had been previously farmed and was in need of restoration. The cooperative farming program was initiated to involve area farmers in the restoration process while also raising a cash crop; it is still used today to prepare the seedbed for planting. Beginning in 1991, Refuge uplands were restored to a mix of warm and cool season grasses, including non-native species, often using seed from an area other than northwest Minnesota. Seed typically was drilled into soybean stubble in the spring. But as restoration knowledge advanced, so did the restoration methods. Diversity of the seed mixes increased, with a stronger emphasis on using forbs (wildflowers) and obtaining local ecotype seed.

Snow seeding

Local ecotype, or local origin of the seed, is critical for upland restorations to withstand natural conditions, ward off disease or other threats, and provide food sources for wildlife. Wildflower starter sites, where forb seed was hand-broadcast over a grass-dominated stand, were planted to increase diversity of select areas and use as harvest sites. In 2000, a new technique called “snow seeding” was tested.

The mix of native grasses and forbs was broadcast over the snow in late winter, taking advantage of the freeze-thaw cycle. Nearly 1,500 acres of grasslands have been restored on Hamden Slough NWR (table 3-4).

Table 3-4: Grassland Restoration

Year	Grassland Restoration
1992	39 acres drill-seeded with grass (native and non-native); 2 acres broadcast seeded over the snow
1993	35 acres drill-seeded with grass (native and non-native)
1996	153 acres drill-seeded with grass (native and non-native)
1997	76 acres drill-seeded with grass (native and non-native)
1998	362.5 acres drill-seeded with grass (native and non-native); 31- ¼ acre wildflower sites were over seeded with forbs
1999	188 acres drill-seeded with grass (native and non-native); 15 of those acres over seeded with forbs
2000	106.7 acres broadcast-seeded with diverse mix (in collaboration w/DLWMD)
2001	145.6 acres broadcast-seeded with diverse mix (in collaboration w/DLWMD); 15-¼ acre wildflower sites were over seeded with forbs
2002	147.5 acres seeded with diverse mix (in collaboration w/DLWMD)
2005	45 acres seeded with native grass; 9 of those acres over seeded with forbs
2008	45 acres broadcast-seeded with diverse mix (under mgmt. of DLWMD)
2010	36 acres broadcast-seeded with diverse mix (under mgmt. of DLWMD)
2011	33 acres broadcast-seeded with diverse mix (under mgmt. of DLWMD)
2012	50 acres broadcast-seeded with diverse mix (under mgmt. of DLWMD)

DLWMD = Detroit Lakes Wetland Management District

Invasive plants are probably the biggest threat to the uplands of Hamden Slough NWR. Currently, a host of invasive plants can be found at varying levels across the entire Refuge. Canada thistle (*Cirsium arvense*) and plumeless thistle (*Carduus acanthoides*) typically are present only in young restorations and rarely pose a threat to the long-term quality of the uplands, although they are visible, easy to identify, and culturally the most-hated group of weeds to the agricultural community. Crown vetch (*Securigera varia*), wild parsnip (*Pastinaca sativa*), and common tansy (*Tanacetum vulgare*) are of greatest concern to District staff. Three qualities make them a real threat: they are prolific seeders, have a long-lasting seedbank, and are easily moved around by mowing or other means.

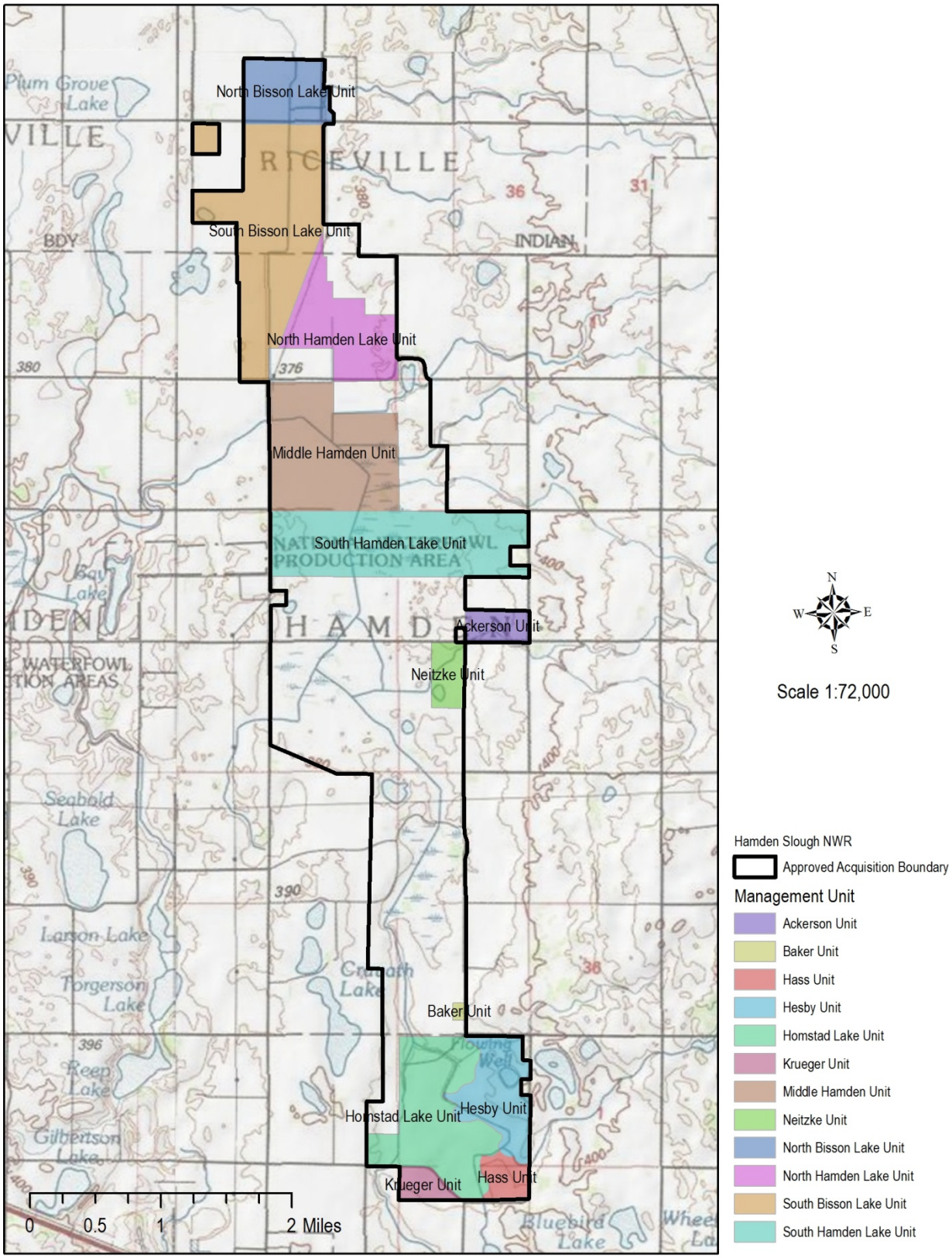
Usually, these are the only invasive plants that are controlled with herbicides. Other invasive species found on the Refuge to a lesser extent include purple loosestrife (*Lythrum salicaria*) and leafy spurge (*Euphorbia esula*). Both are monitored and treated either by hand-pulling or with biological controls as needed. Reed canarygrass (*Phalaris arundinacea*) is found primarily in the Hamden Lake bottom. It is aggressive and forms monocultures, offering little habitat to wildlife seeking structural diversity. Smooth brome (*Bromus inermis*) and Kentucky bluegrass (*Poa pratensis*) are common in Refuge uplands but are not seen as an immediate threat. Proper upland (and lake) restoration and management should keep reed canarygrass, smooth brome, and Kentucky bluegrass in check.

Management Tools

Prescribed Fire

Fire is probably the most widely used and critical tool for tallgrass prairie management. As with herbivore grazing, tallgrass prairie evolved and adapted with fire. The Refuge is divided into different management units (figure 3-25), and those management units may be broken down further depending on specific management needs such as burning. In general, burn units are on a five-year rotation (used by Detroit Lakes WMD staff), although depending on the specific state of the vegetation (i.e., encroachment of trees, etc.), the rotation may be hastened.

Figure 3-25: Management Units



Traditionally, prescribed burning in the tallgrass prairie by managers occurs in mid-spring when resources (people, funds) are more available. However, it is suspected continual early spring burning may favor warm season grasses and forbs, while edging out cool-season grasses and early-emerging forbs. This is not a factor on Hamden Slough NWR due to the lack of native cool season grasses and forbs. As areas on Hamden are diversified with a wider range of native vegetation, burning at times other than the spring should be considered. The Detroit Lakes WMD staff is beginning to experiment with more late summer and fall burns, along with related monitoring.

Prescribed fire for tallgrass prairie management

Grazing

Grazing with cattle was used during the early years of the Refuge to emulate historical grazing by bison and elk prior to European settlement. Grazing not only gave Refuge staff another upland management option, it also demonstrated the willingness of the Refuge to work with local landowners. Usually, these landowners owned land within or next to the designated Refuge boundary and wanted to work with Refuge staff. The grazed uplands usually were of lower quality, dominated by invasive cool season grasses such as reed canarygrass, Kentucky bluegrass and smooth brome; and were primarily located in that portion of the Refuge within the drained Hamden lakebed. As time passed, producers stopped grazing, potentially due to the rising commodity crop market. Grazing on the Refuge diminished and other management tools took its place. The last grazing permit on Hamden Slough NWR was issued in 2000. The reintroduction of cattle grazing on Hamden Slough NWR will be explored with the implementation of this CCP.

Haying

Haying was a traditional economic use when the Refuge was established. Today, about 100 acres of the Hamden lakebed are still hayed in late summer to provide lek habitat for greater prairie-chickens and to simulate wet meadow habitat attractive to birds such as the marbled godwit and common snipe. Western meadowlarks and short-eared owls have also been observed in the hayed portion of Hamden Lake. Varying the haying regime and integrating it with other management tools, including prescribed fire and grazing, could increase the diversity of native plants and provide the habitat structure needed by a suite of breeding grassland birds throughout the Refuge.

Lek habitat for Greater Prairie-Chickens

Farming

Many tracts purchased during the initial establishment of the Refuge were in agricultural production and in need of restoration. Most of the uplands were planted to permanent grass cover, while a small percentage remained in agricultural production. These farmed units were planted to “lure crops” by the Service in hopes of enticing waterfowl to feed in these areas as opposed to the private farmlands surrounding the Refuge. Over the years, these food plots have been farmed to either corn or soybeans. There has been no documentation as to whether or not these plots are being used by waterfowl or neighboring private crops are being depredated. Today, there is a permit available for private landowners with depredation complaints to “take” Canada geese. This permitted “take” coupled with the fragmentation of the south unit supersedes the necessity for maintaining the food plots.

Today, acquired land is converted from row crops to a diverse mix of local ecotype tallgrass prairie vegetation using cooperative farming and following recent Regional guidance. This guidance states that genetically modified organisms can be used for restoration purposes but for no more than five years. Typically, the seedbed is prepared by farming the area with Roundup Ready® corn and soybeans in alternate years; ensuring the final crop year prior to restoration is planted in soybeans. Using Roundup Ready® crops safeguards the fields from significant broadleaf weed infestation with minimal chemical carryover, resulting in successful prairie vegetation establishment. Fields are planted within five years of acquisition based on seed availability, resources, weather, and other factors.

Mowing
Mowing as a prairie management tool is only used if there is a weed complaint on new prairie restorations. If a weed complaint is voiced and no resolution is made, the unsightly vegetation (usually thistle, *Cirsium spp.*) is removed by mowing (hand-clipping if the area is small). Otherwise, the native grasses and forbs are allowed to become established and out-compete the unsightly weeds, producing a healthier, more diverse native prairie.

Tree Removal
Tree removal is a critical tool used today in grassland management. Since European settlement, the number of trees (native and non-native) on the landscape has increased dramatically due to factors such as fire suppression, wildlife plantings, and shelterbelt establishment. Trees out-compete prairie forbs and grasses for the necessary light, water, nutrients, and space needed to flourish. Tree encroachment fragments the grassland landscape, decreasing its suitability for area-sensitive grassland birds. Areas of trees also provide predator lanes for some mammals and perch sites for avian predators and parasites. Tree removal will be a continuing practice on the Refuge to ensure longevity of tallgrass prairie vegetation and improve habitat for grassland nesting birds and other prairie-obligate wildlife. High voltage power lines on the Refuge also provide predator perches, so removal or burial of power lines, while costly, is desirable over the long term.

Partners for Fish and Wildlife Program

The Partners for Fish and Wildlife Program provides technical and financial assistance to willing landowners wanting to restore and/or manage prairie wetland habitats within the Hamden watershed and beyond. Currently, working with partners and landowners to improve watershed sustainability occurs mostly in an opportunistic manner. The number of projects since Refuge establishment is minimal. Potential benefits of private lands habitat improvements within the watershed include preserving wildlife species for future generations, helping recover endangered or threatened species, improving quality of life, enhancing recreational opportunities, providing flood reduction, and recharging local and regional groundwater (FWS, 2005).

Research and Monitoring

Monitoring and research has always been a focus at Hamden Slough NWR. Collaborations with local universities, other government agencies, conservation organizations, and others have provided important information to support and strengthen the case for conserving prairie-wetland habitat and the benefit it provides to both wildlife and people.

Research

Seepage Analysis of Bisson Lake
During the mid-1990s, many landowners voiced concerns about potential seepage and flooding of nearby private land as a consequence of the proposed Bisson Lake restoration. Because of potential impacts to local farming economy near the Refuge, the BRRWD was hesitant to approve permits for the North Star 2000 project, which involved the restoration of 130 wetlands including Bisson Lake. The Service submitted a Challenge Cost Share Grant, partnered with BRRWD and the Red River Water Management Board, for the analysis. The grant was funded and the seepage analysis was conducted by North Dakota State University Soil Science Professor Jim Richardson from 1996–1999. A summary of findings included that groundwater moves into Bisson Lake, not out of it, and moves south to the Hamden Lake basin.

Where the potential of water movement to private land existed (northeast side), easements were already in place.

Simulation of Runoff and Wetland Storage in the Hamden and Lonetree Watershed Sites within the Red River of the North Basin
After the 1997 flooding of the Red River Valley, U.S. Geological Survey (USGS) began investigating sites to explore the potential increase or decrease of flood effects due to wetland restoration. The seepage analysis conducted from 1996–1999 sparked the interest of USGS and the National Soils Lab in groundwater movement. Bisson Lake was selected as one of the study sites in 1998 to examine precipitation and storage capacity of wetlands. All factors affecting water movement into and out of Bisson Lake including light reflection, sublimation, and transpiration, were closely monitored. The four-year study, published in 2004, concluded that: 1) peak streamflows during a flood can be reduced 1–6 percent with a restored wetland; 2) soils of the Hamden site stored as much water as the wetlands; and 3) soil management practices in combination with water storage practices may result in reduced waterflow from wetlands during large precipitation and snowmelt events.

Soil and Water Phosphorous Interaction in Restored Wetland Landscapes of Western Minnesota
Soil sampling and mapping were conducted as part of a North Dakota State University Ph.D. research project to investigate changes in soils as related to wetland restoration. The research suggests that runoff containing fertilizers and sediments causes an increased collection of phosphorous in wetlands. As a result, normal aquatic vegetation establishment is disrupted and the consequence is a monotypic stand of hybrid cattail. The study was finalized and published in 2005.

Refuge Cooperative Research Program (RCRP) Impoundment Study
From 2005–2007, the Refuge participated in a joint FWS/USGS study to monitor the effects of drawdowns on waterbird and waterfowl use during spring and fall as part of the RCRP. Participants were provided with a drawdown prescription and monitoring protocol to follow during the three-year study. Field work involved weekly survey of waterbirds and waterfowl, weekly activity surveys of four waterbird guilds, waterbird flushing counts, water and invertebrate sampling, vegetation sampling, water level management, depth readings, and vegetation manipulation. A cooperative agreement with Concordia College (Moorhead, MN) was signed to help carry out all the field activities. Although preliminary results were shared, further data analysis was recommended. We are still awaiting the final results and recommendations.

Fish, Invertebrate and Waterfowl Numbers on Hamden Slough NWR and Adjacent Anderson WPA
Fish, especially fathead minnows (*Pimephales promelas*), have become an increasing detriment to the health of northwestern Minnesota wetlands, and in turn, may impact waterfowl use. Students from Concordia College (Moorhead, MN) conducted waterfowl surveys on Hamden Slough NWR (2007–08) and Anderson WPA (2008) from spring to fall migration. On those same study wetlands, both invertebrate and fish were sampled and analyses run. Preliminary conclusions support that wetlands with less or no fish had higher numbers of invertebrates and duck use, although future research may be prompted.

Avian Influenza Monitoring
During July and August of 2006, Bisson Lake was one of many sites sampled for a USDA nationwide study exploring avian influenza (AI) in shorebirds. The goal was to collect cloacal samples from 200 shorebirds in every state; a total of 193 shorebirds from nine species were sampled at Bisson Lake. The project was coordinated by Pete Sahr, USDA Animal and Plant Health Inspection Service-Wildlife Services. Mist-netting was conducted by Dr. Greg Hoch and student volunteers from Concordia College, Moorhead, MN. All samples were sent to Vet Med Diagnostics Laboratory in St. Paul, MN. None of the shorebirds collected from Bisson Lake tested positive for AI.

Secretive Marshbird Surveys
From 2003–2005, the Refuge was the site for marshbird survey protocol trials developed by Dr. Courtney Conway, USGS-Biological Resources Division, University of Arizona. Dr. Conway believes that marshbirds are considered indicator species, because they consume a wide variety of invertebrates, another indicator of wetland health. Their presence could, therefore, be a measure for wetland quality and

restoration success. Contractor Sherri Norland conducted the marshbird surveys during the trial on Hamden Slough NWR.

Monitoring

Over the years, although not strongly linked with research, regular monitoring of bird populations existed on Hamden Slough NWR. From spring to fall migration and beyond, wetland birds especially were monitored for time of arrival, departure, and breeding, if possible. This was due to their obvious visibility on Refuge wetlands. The regular monitoring of Refuge wetlands led to the discovery of nesting American avocets and visits by common moorhens and a piping plover.

Nesting American Avocets

A more structured approach was used for grassland bird monitoring, because they are more difficult to detect. Point counts, a common way to estimate breeding grassland bird pairs, were conducted from 1994–1996. During the three years of point counts, 45 species (including incidentals) were detected at 34 points. Again in 2009, point counts were conducted in three different grassland habitat types: mowed reed canarygrass, standing reed canarygrass, and restored tallgrass prairie. During the season, 561 birds of 31 species were detected. Although species richness among habitat types was generally the same, the greatest abundance of birds was found using the tallgrass prairie. However, a more unique guild of birds associated with shorter vegetation was observed in the mowed area including upland sandpipers, field sparrows, greater prairie-chickens and marbled godwits. These birds were not found in the other two habitat types due to the taller, dense vegetation.

Today, monitoring daily bird use of the Refuge is more difficult because no staff is located onsite. Fortunately, two Refuge volunteers conduct weekly roadside bird surveys from ice-out to freeze-up every year. Although Refuge-managed wetlands are the focus of the surveys, all incidental birds are recorded, which gives staff valuable information on arrival of species and areas of use. In addition, staff maintains and checks eight nest baskets on or near the Refuge annually. A duck banding program in conjunction with Tamarac NWR began in 1998. Since the onset of the program, 1,599 ducks have been banded; 1,444 were mallards (*Anas platyrychos*). The majority of banded ducks have been recovered along the Mississippi flyway in states such as Iowa, Missouri, Arkansas, Mississippi, and Louisiana.

Information is lacking as to the extent of vegetation monitoring of Refuge habitat while the Refuge was staffed. Monitoring of Refuge habitat will be a focus when this CCP is implemented.

Visitor Services

Offering programs for visitors is a way to connect people with nature at Hamden Slough NWR. By participating in these programs, people will learn how the integrity of the prairie-wetland landscape is relevant in their daily lives, enjoy the abundance of wild places and things around them, and deepen their personal connections to the natural world.

Hunting

Hunting programs on the Refuge are relatively new. Muzzleloader deer hunting began during the winter of 2008 on all Refuge fee lands. This option allows for a quality deer hunt while helping maintain the white-tailed deer population on and adjacent to the Refuge (FWS, 2007). The muzzleloader season occurs in late winter after the waterfowl migration, thus limiting any disturbance.

Mentored youth hunt on the Refuge

The sport of waterfowl hunting is declining in not only Minnesota but throughout the United States. To encourage youth interest in hunting, the Minnesota DNR selects one day each year during which any Minnesota youth, age 15 or younger, can participate in a quality hunt when accompanied by a non-hunting adult. The youth waterfowl hunt on Hamden Slough NWR was established under the same hunting plan as the deer hunt (FWS, 2007) but opened a year later in 2009. The Refuge youth hunt is open only in Audubon and Riceville Townships, which is approximately 60 percent of the Refuge, to reduce wildlife disturbance and maintain 40 percent of the land and water as sanctuary. The Service partners with DU and the Minnesota DNR to sponsor a mentored youth hunt on the Refuge, a more formalized program to introduce youth to the sport of waterfowl hunting.

On Refuge lands within the White Earth Reservation (Sections 27 & 35 of Riceville Township), legal hunting (and other uses) is not bound by Refuge seasons or state or federal regulations. Hunting is allowed by tribe members in accordance with Tribal regulations.

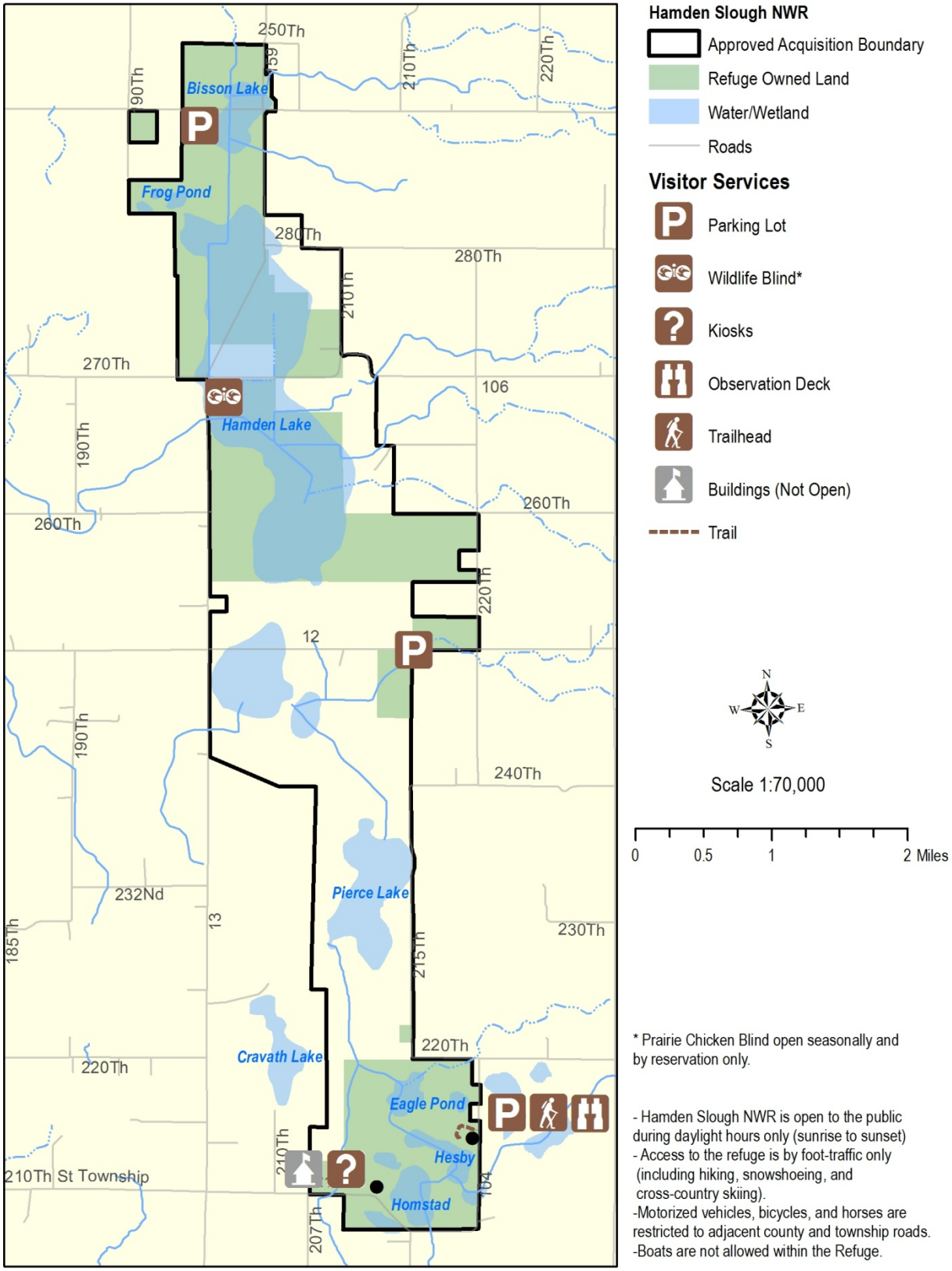
Wildlife Observation and Photography

Wildlife observation and photography are favorite pastimes at Hamden Slough NWR. Although roadways fragment habitat and create dangerous places for wildlife, they also allow for easy viewing of the area's natural resources. Many roads intersect the Refuge. On the south end, Becker County Road 104/144 runs alongside most of the Big 6 wetlands, allowing for great views of wildlife on the water. On the north end of the Refuge, staff worked with Becker County to widen and slope Becker County Highway 14 to allow easy pullover access for viewing Bisson Lake during spring and fall migrations. This is also a favorite stop on the annual Hamden Slough NWR field trip as part of the Detroit Lakes Festival of Birds (figure 3-26).

In addition to roadsides, there are two locations that provide great viewing and photography opportunities. On the south end of the Refuge, the Hesby Memorial Trail and overlook offers a short, accessible walk through a restored prairie ending with a breathtaking view of Hesby wetland and beyond. To the north, a prairie-chicken lek is located in the hayed portion of the drained Hamden lakebed, off County Road 113 and County Highway 13. Each spring, male prairie-chickens dance on the lek, booming to attract females for breeding. Observation from the road is possible, but the Service places a viewing blind on the lek for people to reserve and observe the spectacle up close. Although there are no established photography blinds on Hamden Slough NWR, great opportunities for wildlife photography are possible along roadsides and above-mentioned structures.

Great views of wildlife on the water

Figure 3-26: Visitor Services Facilities



Environmental Education and Interpretation

Currently, the Refuge does not have a formal environmental education program due to lack of trained, available staff. On request, District staff or volunteers may work with educators and other leaders to present programs at local schools and organizations. Expansion of environmental education opportunities at Hamden Slough NWR is a high priority in the coming years.

Learning at the Refuge

Recently, the "Prairie-Chicken Cam" project was initiated to help connect children to the natural world of Hamden Slough NWR. First, a live webcam was mounted on the blind at the prairie-chicken lek to record and display breeding behavior on an updated version of the Hamden website. Although technical issues still require resolution, the goal is to "stream" the video to the website for live viewing. Second, a spring prairie curriculum, centered on the prairie-chicken, was developed for 4th grade students. This curriculum can be used in conjunction with the webcam. Finally, an updated Prairie Trunk, funded by the Minnesota Prairie Chicken Society, was developed for educators to use with the prairie curriculum or as a stand-alone aid in teaching about prairie ecology.

To further environmental education opportunities at Hamden Slough NWR, the Service staff worked with multiple partners to construct and furnish an environmental education building at the headquarters area. This shelter will expose local school children to the prairie-wetland setting by incorporating the ecology of the area into the STEM (Science, Technology, Engineering, and Mathematics) curriculum. District staff, partners, and volunteers will work with area educators to expand the current curriculum to meet the needs of the local school districts.

Environmental education building

Interpretation at the Refuge is minimal due to lack of staff. Currently, no formal Refuge brochure exists; only a bird list and informational leaflet are available. One kiosk and one interpretive panel are at the old headquarters area, and one interpretive panel is near the prairie-chicken lek. Prairie Fun Day, an annual public event celebrating prairie-wetland habitats, was held at Hamden Slough NWR in 2010 and 2011. Finally, an interpretive program is held in conjunction with the mentored youth waterfowl hunt at the Refuge.

Friends Group and Volunteers

The Refuge always has relied on volunteers to help sustain the biological and visitor services programs. In the past, volunteers helped clean up building sites, greet visitors, and assist with management and maintenance activities. Today, volunteers continue to assist with weekly roadside bird surveys, habitat restoration and management activities, maintenance of equipment, cleaning of duck nest baskets, and more. Finally, volunteers are integral to the continuation of the Prairie-Chicken Cam and related projects. In all, volunteers contribute approximately 75 hours annually.

Hamden Slough NWR is served by Friends of the Detroit Lakes WMD. The Friends group was organized in 2003 and only just began to expand their activities to include the Refuge. Currently, the Friends group sponsors and assists with two events on the Refuge: Prairie Fun Day and the mentored youth waterfowl hunt. In addition, the Friends group participates in the Detroit Lakes Festival of Birds to help increase awareness of Hamden Slough NWR and the Detroit Lakes WMD.

Outreach and Partnerships

The current level of outreach for Hamden Slough NWR is limited and dictated by available staff time. The primary method of outreach is submission of new releases to local and regional papers to promote special events or to provide Refuge-specific information. In addition, District staff, volunteers, or Friends group members may appear on the local-access TV channel or present information for local radio stations, but that is dependent on staff time as well. Refuge volunteers participate each year in a variety of events such as parades, fairs, and more in order to bring awareness of the Refuge and District to local communities.

Partners continue to play a critical role in the function of Hamden Slough NWR. These partnerships allow opportunities to accomplish goals that any one organization could not achieve alone. The Service works with a wide variety of partners including but not limited to: Red River Basin Commission, Buffalo-Red River Watershed District, Minnesota DNR, White Earth Band, Ducks Unlimited, Isaac Walton League, Safari Club International, Minnesota Prairie Chicken Society, Lakes Area Birding Club, and more. Many of these partners were instrumental in the initial establishment and restoration of the Refuge.

Administration

In late 2006, the decision was made to combine the staff and management of Hamden Slough NWR with the Detroit Lakes WMD. Although Refuge staff was moved to the WMD office, some buildings such as the old Refuge office, garage, and equipment shed still exist. Plans are to demolish the old office building and garage in the very near future. Because the staff was moved, there are no Refuge points of contact for visitors to Hamden Slough NWR. All staff is located roughly ten miles from the Refuge, which can be an inconvenience to visitors who have questions or need information. Therefore, an environmental education classroom was constructed onsite at the Refuge headquarters area with the help from many partners. This will serve, in part, as a contact station for visitors, as well as an educational classroom for students, groups, and other organizations. Ultimately, the goal is for volunteers to serve the role as contact for Refuge visitors and education building users.

Old headquarters

Law Enforcement

Law enforcement officers at Hamden Slough NWR help the public understand and obey the laws that protect our natural resources. They work closely with state, tribal, and local government offices to enforce federal and state hunting regulations that protect numerous wildlife and plant species from unlawful take or destruction.

Easements

There is currently one private easement totaling 24 acres that borders the east side of the North Bisson Unit. It is a flowage and wetland easement that allows for manipulation of water levels on the north end of the Refuge without objection or retaliatory action by the owner. The flowage and wetland easement is perpetual.